REQUEST FOR PROPOSAL
(FOR CONSTRUCTION CONTRACT)

SOLICITATION NO. W9128F25RA043

POWER INDEPENDENCE, MISSION CONTROL STATION
PN CRWU223006 (FY27)

BUCKLEY SFB, COLORADO

JUNE 2025

US Army Corps of Engineers ®
Omaha District

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SPECIFICATIONS FOR CONSTRUCTION
POWER INDEPENDENCE MISSION CONTROL STATION
PN CRWU223006 (FY27)

BUCKLEY SFB, CO

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SECTION 01 14 00

WORK RESTRICTIONS
11/11

PART 1 GENERAL

Attachments:
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DD Form 128 - Request for Unescorted Visitor Access (temp, up to 30 days)

1.1 REFERENCES

The design publications listed below shall be used as sources of criteria for the architectural design. The most current edition of the code or standard (with errata and addenda) available at the RFP proposal submission deadline shall be used as criteria for the design - unless noted otherwise. The criteria from these sources may be supplemented but not supplanted, by applicable criteria contained in nationally recognized codes and standards.

INTELLIGENCE COMMUNITY STANDARD (ICS)

ICD/ICS 705	Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities
ICS 705-1	(2010) Physical and Technical Security Standard for Sensitive Compartmented Information Facilities
ICS 705-2	Standards for the Accreditation and Reciprocal Use of Sensitive Compartmented Information

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 4-010-05	Sensitive Compartmented Information Facilities Planning, Design, and Construction, with changes, dated 1 February 2013

1.2 SCOPE

The majority of work under this Project is contained within the Restricted (PL-1) Area at Buckley SFB, CO. Utility connections are the only significant scope that occurs outside the Restricted Area. Some work will occur within the Restricted Area, but outside the project construction boundary depicted in the project drawings. Coordinate the staging, phasing, and construction of all construction activities with the Government to ensure that secure operations continue within the Restricted Area through the duration of the Project. The Restricted (PL-1) Area is enclosed by a double fence perimeter with an array of security features. Do not alter, relocate, or affect the established perimeter fence in any way without prior approval by the Government.

1.3 DEFINITIONS

1.3.1 Construction Secure Area Perimeter

A potentially moving boundary established during project construction by which the Site Security Officer (SSO) and Site Security Manager (SSM) assign layers of oversight for purposes of Construction Security Plan (CSP) implementation in compliance with ICD/ICS 705. This perimeter is established by a site perimeter fence (in this case, the primary site fence described below and in the design drawings) early in construction and prior to the construction of the physical, permanent secure area boundary as defined by the built facility perimeter. Once the permanent secure area boundary is substantial enough to establish effective access control (as determined by the SSM), the boundary may be re-established by the SSM to isolate secure area construction from non-secure area construction within the facility for more effective secure area oversight. Coordinate the perimeter(s) and transitions from one CSP implementation perimeter to another with the SSM and with the anticipated order of construction, through the duration of the project. When work is not ongoing (or no onsite presence by the Prime Contractor), the entry gate to the perimeter fence shall be secured with a keyed padlock(s) or similar locking mechanism.

1.3.1.1 CSP and Construction Secure Area Implementation

CSP implementation will occur on the project once the SSAMP is approved, the project site is cleared, the secure site perimeter fence is constructed and approved by the SSM, and once the proposed facility foundations are laid. CSP implementation will occur from that point through the entire duration of construction to include procurement and installation of any bid options.

Contractor responsibilities associated with CSP implementation on this project will only terminate upon full Government acceptance of all work within the secure area perimeter and upon the Contractor's departure from the project site - including procurement and installation of any bid options awarded under this contract. While it is the Contractor's responsibility to establish the order of work within the constraints established within this contract, no work on the vertical facility, other than placement of below-grade features and foundations, shall occur without implementation of Government and Contractor responsibilities associated with the approved CSP - as described herein.

Document intended order of work and required points of interface with CSP requirements in the Security and Site Access Management Plan as defined below - as well as reflect this requirement in the project schedule.

1.3.2 Free Work Zones or Free Zones

A work area bounded by an established perimeter designated by Base Security Forces (or other authorized Government authority) for construction work to occur within a larger, secure or restricted area. Generally, once inside a designated free zone, oversight and ecort requirements for construction work are relaxed, and only the perimeter of that work zone is monitored. See the project drawings for a list of anticipated free zones, and see the requirements below and in other sections of this RFP for procedures for requesting additional free zones.

1.3.3 Secure Area

Construct and accredit areas identified in the RFP as "secure area" to the criteria listed below. The listed criteria carry impacts to all building systems within the designated boundary. Use the most current version of the referenced criteria available at the proposal submission deadline.

a. ICD/ICS 705 - Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities.

b. ICS 705-1 - Physical and Technical Security Standards for Sensitive Compartmented Information Facilities.

c. ICS 705-2 - Standards for the Accreditation and Reciprocal Use of Sensitive Compartmented Information.

d. UFC 4-010-05 - Sensitive Compartmented Information Facility Planning, Design and Construction.

The design drawings and specifications indicate the technical mitigations required by the project. This specification indicates the Contractor and Government's role(s) in administering the secure areas during construction for accreditation by assigned authorities.

1.3.4 Security and Site Access Management Plan (SSAMP)

A detailed plan that acknowledges, describes, and details all unique access control, security, and phasing requirements in this Contract. Project-specific requirements for the SSAMP are described below.

1.3.5 Restricted (PL-1) Area (RA)

References the restricted access area found at Buckely SFB, CO. Access into this area is highly controlled, coordinate construction activities with existing RA access control and security procedures.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Project Security And Site Access Management Plan; G, RO

1.5 PROJECT SECURITY AND SITE ACCESS MANAGEMENT PLAN (SSAMP)

Prior to the start of construction, provide a Project Security and Site Access Management Plan (SSAMP) for approval by the Government. The SSAMP shall incorporate the constraints described below and throughout the RFP. This shall include, but is not limited to, the following information. Clearly separate the plan into "Secure Area" work and non-"Secure Area" Work as defined in the RFP:

a. List of primary and secondary Contractor POCs for Project security and

access management.

b. List of Contractors and Subcontractors requiring site access.

c. Anticipated free zones(s) with dates and durations.

d. Anticipated dates and durations of various work activities that will require Government oversight and/or escorts per the requirements in this RFP.

e. Description of Contractor processes and procedures associated with Secure Area construction, Government oversight, accreditation, and associated security requirements.

f. Anticipated procedures for Contractor site security and access management for each work activity.

g. Anticipated vehicle and equipment list requiring access to restricted sites.

h. Anticipated usage of perimeter fences, barricades, barriers and similar at free zone perimeters, etc.

i. List of anticipated closures/outages, etc that may impact Government oversight, access to other portions of the Restricted Area, or work outside of normal hours listed below.

j. CUI document storage and handling procedures.

k. Procedures for advising Subcontractors and delivery activities on the location of the project site and appropriate POCs (primary and secondary) for Security Forces to verify project deliveries against.

l. Describe the technical approach to design and construction of the facility(ies). Include considerations for management of both the "Secure Area" construction security (in accordance with UFC 4-010-05 and ICD/ICS 705) and work within the Buckley SFB Restricted Area (RA).

The SSAMP shall be a living document that records the Contractor's approach for compliance with work restrictions documented herein. As Contractor requirements evolve, update the SSAMP for use and reference by the Government. Coordinate SSAMP updates with overarching construction schedule and "lookahead" activities defined in 01 32 01.00 10 PROJECT SCHEDULE.

1.6 ORDER OF WORK RESTRICTIONS

Conduct the order of work in accordance with the following constraints:

a. The Restricted (PL-1) Area (RA) will remain in operation during the entire construction period. Conduct operations so as to cause the least possible interference with normal operations of RA activities.

b. Request permission to interrupt any roads, railroads, or utility service in accordance with requirements listed in 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS.

c. Permission to establish new free work zones, as well as Government escorts and oversight shall be coordinated in compliance with the

requirements listed below.

d. Plan outages associated with the project Redundant Power Feed well in advance. Notify the Government of any required outages that may impact any RA facilities in compliance with utility outage request requirements in 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS.

1.7 DESIRE FOR INNOVATION

The Government is looking for ways to streamline construction and manage labor and other resource constraints in an effort to mutually reduce costs and achieve an aggressive schedule while minimizing impact to the Base and Base operations. Consider these constraints when developing the project schedule and work activities, and propose innovative and/or alternative solutions for Government consideration. Any non-standard solutions require Government review and formal acceptance prior to implementation.

1.8 DOCUMENT CONTROL

Distributed hardcopies of documents (including the design analysis, plans, and specifications) are marked Controlled Unclassified Information (CUI), store these within the project perimeter or locked in the contractor's construction office when not in use and during non-work hours. Ensure the return of plans as entities complete their work activities. Destroy all hardcopy documents not turned over to the Government upon project completion.

1.9 BASE ACCESS AND SECURITY

1.9.1 Activity Regulations

Ensure that Contractor personnel employed on the activity become familiar with and obey activity regulations including safety, fire, traffic and security regulations. Keep within the limits of the work and avenues of ingress and egress. Wear hard hats in designated areas. Do not enter any restricted areas unless required to do so and until cleared for such entry. Mark Contractor equipment for identification.

1.9.1.1 Subcontractors and Personnel Contacts

Provide a list of contact personnel of the Contractor and subcontractors including addresses and telephone numbers for use in the event of an emergency. As changes occur and additional information becomes available, correct and change the information contained in previous lists.

1.9.1.2 Identification Badges and Installation Access

a. Each Contractor and Contractor employee to work on the job at Buckley must obtain a vehicle pass to enter the base. The pass will be obtained the first day of work at Buckley, or not later than the next working day. To obtain the vehicle pass, the vehicle operator must have in his possession, a current, valid driver's license, current vehicle registration, and current proof of insurance. Procedures for obtaining a base pass will be identified at the Pre-Construction Meeting. Expired/unregistered vehicles will not be allowed on the base. Employees who are terminated from employment will surrender any and all identification media and vehicle passes to their immediate supervisor, who will in turn surrender same to the Pass and ID Office,

and the supervisor will immediately escort the terminated employee off base, and notify Base Police of the termination. Access to Buckley SFB shall be through the Mississippi Avenue Gate. The Contractor shall provided the Buckley SFB Base Security Police a copy of a completed "Contractor Employee Verification List" Attachment, which is to include the names of all subcontractors and suppliers, and the names and social security numbers of all employees requiring access to the Base. The list shall be revised in its entirety and a new copy provided to the Buckley SFB Security Police as persons/companies are added and/or deleted.

b. All drivers on Buckley will have in their possession a valid driver's license, valid vehicle registration, and proof of vehicle insurance while operating any vehicle. If vehicle is registered to someone other than the operator, the operator must provide a notarized letter from the registered owner, authorizing the operator permission to operate the vehicle. Access by vehicles to the Base and project site is at the sole discretion of the Government. Security process and procedures at the Base change over time. Coordinate specific access details with the Government after contract award.

c. The Contractor's Superintendent must notify Base Police through the Contracting Office prior to any work to be performed on non-scheduled hours/days (evenings, weekends, holidays). Any personnel working on non-scheduled hours/days must check in with Base Police, prior to and at the completion of the work.

d. All equipment and materials are the responsibility of the Contractor. Make sure that all equipment and materials are properly secured at the end of the work day. Any work area found by Base Police to be unsecured will be checked for intruders and the responsible Contract Superintendent will be called in to secure the areas/equipment.

e. If any roadway is to be blocked for any reason, the Contractor must notify, through the Contracting Office, the Base Police of the blockage, prior to the blockage, and must ensure that proper signs are provided by the contractor and installed to divert traffic around the affected area. As much lead time notification as possible is appreciated for proper coordination, and notification of other activities on base.

f. Contractors, Subcontractors and all personnel who report for work, and do not know the location of the job site, will be held at the entry gate to await escort service from the Construction Superintendent.

g. Base speed limits are strictly enforced with the use of radar equipment. The base speed limit is 30 MPH, unless otherwise posted. The speed limit through the gates is 20 MPH. Motorcycle operator/riders must wear protective headgear (helmets) while riding on base. Mandatory seatbelt laws are in effect on base. Seatbelts must be fastened prior to entering the base. Cell phones may not be used while driving on any Air Force Base, including Buckley SFB.

h. The Mississippi Gate is the main gate of Buckley Space Force Base and is open 24/7. The 6th Ave. gate is open 0600 to 1800 daily except federal holidays, weekends, and potentially 11 additional days over and above the federal holidays listed in Section 01 30 00.24 OTHER ADMINSTRATIVE AND SPECIAL REQUIREMENTS (Family Days the day before a holiday). Deliveries to the base and for any contractor that does not

have a pass, but a work order will have to go through the Large Vehicle Inspection Point (LVIP) which is open from 0600 to 1600 daily expect federal holidays and weekends. For Contractors that are receiving their pass for the first time, they will receive the pass from the Visitor Center located near the Mississippi Gate, which is open 0700 to 1500 daily except for federal holidays and weekends. Any request for passes has to be dated for a minimum of 72 work hours after the submission date or they will be rejected and escort for pass will be required.

i. No privately owned weapons or contraband (drugs, etc.) are permitted on any military installation, at any time. Violators will be prosecuted through the Federal Magistrates Court in Denver. Cameras are also considered to be contraband on this installation.

j. Buckley SFB is considered to be a closed facility. No unauthorized tours or visitors will be allowed on the installation.

1.9.1.3 No Smoking Policy

Smoking is prohibited within and outside of all buildings on installation, except in designated smoking areas. This applies to existing buildings, buildings under construction and buildings under renovation. Discarding tobacco materials other than into designated tobacco receptacles is considered littering and is subject to fines. The Contracting Officer will identify designated smoking areas.

1.10 RESTRICTED AREA (RA) ACCESS AND SECURITY

Equipment and personnel entering the Buckley SFB RA shall comply with the following as applicable to the work activities and location in which the work is being conducted.

1.10.1 Regular Working Hours within RA

Work Hours within the Buckley SFB RA are 7:00 a.m. to 5:00 p.m. daily (Monday through Friday), excluding federal holidays. Access to the base during other times must be requested in writing from the Contracting Officer and will be granted only for extenuating circumstances. Federal Holidays and weekends are considered as scheduled non-workdays.

1.10.1.1 Work Outside Regular Hours

Work outside regular working hours requires Contracting Officer approval. Submit application 21 calendar days prior to such work to allow arrangements to be made by the Government for inspecting the work in progress, giving the specific dates, hours, location, type of work to be performed, contract number and project title. Based on the justification provided, the Contracting Officer may approve work outside regular hours. During periods of darkness, the different parts of the work must be lighted in a manner approved by the Contracting Officer. Make utility cutovers after normal working hours or on Saturdays, Sundays, and Government holidays unless directed otherwise.

1.10.2 Access Within RA, Inside Secure Area Perimeter

This project requires construction and accreditation of a Secure Area. As such, ensure the facility is constructed and accredited in full compliance with the referenced criteria, and as directed by the project

Construction Security Plan (CSP) and the Site Security Manager (SSM). The contractor shall also ensure construction of a fully compliant facility within the Restricted (PL-1) Area. Government and Contractor responsibilities for the duration of this project are listed below. Close coordination of these responsibilities is required and will require continuous coordination and fine-tuning through the duration of the Project.

1.10.2.1 Contractor Responsibilities

a. Provide GSA approved secure safe(s) for plans and document storage on site.

b. Erect a secure chain link fence around the entire Secure Area site with a single securable access point, per RFP plans and requirements.

c. Contractor will conduct initial vetting for workers using e-Verify to confirm all workers are US Citizens or US Persons and present a roster of all workers to the Site Security Manager (SSM, Government) who will verify using birth certificate, passport, or I-9 approved identification. Any additional workers added after the initial roster is submitted will not be allowed access until proper vetting has been completed, which may take up to 30 days.

d. After successful validation of US Citizen or US Person status, the validated construction workers will be added to the access control roster, issued a site access badge and receive a security briefing from the SSM. The security badge shall be in the possession of the worker while on site and shall be required for access to any secure or controlled area.

e. All construction workers performing finish work and/or telecommunications infrastructure within the Secure Area will either be SECRET cleared workers or will be escorted at all times by SECRET cleared guards or escorts provided by the Government.

f. Workers will enter the site through the controlled access point only and must be on the controlled access roster provided to the onsite guard.

g. No Privately Owned Vehicles (POVs) will be authorized within the Restricted (PL-1) Area or project construction site. Only marked commercial and construction vehicles will be allowed access - only after validation through the SSM and inspection and checking at the controlled access point. POV parking for workers will be made available in the vicinity of the Project site, outside the RA.

h. All construction equipment entering the site will be validated through the SSM.

i. If the contractor has to perform work outside normal working hours, they shall coordinate the requirement as prescribed in "Work Outside Regular Hours," above.

j. The contractor shall establish and maintain a Secure Storage Area for construction material and equipment with security lighting.

k. All construction materials will be stored within the fenced temporary Secure Storage Area not open to public view upon arrival. As

materials are identified/selected for Secure Area construction by the SSM, they will be used or moved to the separate secure container within the fenced temporary Secure Storage Area to be accessed by the project manager through coordination with the SSM.

l. Materials required for Secure Area construction will be procured through random selection from conventional sources. The contractor will obtain standard construction materials for the overall construction of the building and after SSM inspection upon arrival they will be stored inside a secure storage area (fenced enclosure).

m. Once general materials are selected for use in Secure Area construction, but are not immediately used as well as any materials/equipment that are ordered required specifically for the Secure Area arrive and are not immediately installed, they will be stored in a separate contractor provide secure container (Sea-Land container, Connex, ISU, etc.) or within the Secure Area once it is able to be secured with sole control of access retained by the SSM for both container and Secure Area.

n. The Contractor shall notify the Government not less than 7 days prior to sheathing and/or cladding activities that will enclose wall cavities on Secure Area perimeters. Advanced notice shall be made to the project SSO for inspecition, verification, and documentation of those conditions.

1.10.2.2 Government Responsibilities

a. Security Oversight and vetting.

b. Re-verification of contractor's vetting of employees as US Citizen or US Person status.

c. There will be a chain link fence erected around the entire SOF site with a single access point that will be manned during work hours by personnel (Government provided) tracking and validating all access/vehicles/supplies to the construction site with oversight provided by the SSM or authorized Cleared American Guard (CAG) personnel.

d. At the end of each work day the construction site will be checked by the Government to verify all workers have departed and the site access gate will be secured by the Government and randomly checked until the next work day.

e. Once construction proceeds to a point where the Secure Area perimeter is defined, the SSM will oversee the process of having CAGs and Cleared Escorts in the Secure Area during all work operations.

f. Once walls/barriers to the Secure Area have been put in place there will be (Government provided) SECRET cleared escort(s) in each walled off area to maintain secure construction during the build.

g. As required for inspection, the SSM will randomly select materials from general stock for use in construction of the Secure Area.

h. The SSM will maintain all site access log information (visitors, workers, security events, access control logs, etc).

1.10.3 Access Within RA, Outside Secure Area Perimeter, within established Free Zone

See the project drawings for anticipated Free Zones for this project. These areas have been previously reviewed by Base Security Forces as acceptable Free Zone perimeters. Contractor shall acknowledge or advise the Government to any intended changes to these boundaries in their SSAMP. Close coordination of these boundaries and the responsibilities listed below are required and will require continuous coordination and fine-tuning through the duration of the Project.

1.10.3.1 Contractor Responsibilities

a. Erect a secure chain link fence around the entire Free Zone perimeter with a single securable access point, per RFP plans and requirements.

b. Contractor will conduct initial vetting for workers using e-Verify to confirm all workers are US Citizens or US Persons and present a roster of all workers to the Site Security Manager (SSM, Government) who will verify using birth certificate, passport, or I-9 approved identification. Any additional workers added after the initial roster is submitted will not be allowed access until proper vetting has been completed, which may take up to 30 days.

c. After successful validation of US Citizen or US Person status, the validated construction workers will be added to the access control roster, issued a site access badge and receive a security briefing from the SSM. The security badge shall be in the possession of the worker while on site and shall be required for access to any secure or controlled area.

d. All construction workers performing work within the Free Zone perimeter will either be SECRET cleared workers or will be escorted to and from the Free Zone perimeter.

e. Workers will enter the site through the controlled access point only and must be on the controlled access roster provided to the onsite guard. See requirements above regarding controlled access point.

f. No Privately Owned Vehicles (POVs) will be authorized within the RA. Only marked commercial and construction vehicles will be allowed access - only after validation through the SSM and inspection and checking at the controlled access point. POV parking for workers will be made available in the vicinity of the Project site, outside the RA.

g. All construction equipment entering the Restricted Area will be validated through the SSM.

h. If the contractor has to perform work outside normal working hours, they will coordinate the requirement as prescribed in "Work Outside Regular Hours," above.

i. The contractor shall establish and maintain a materials and stockpile area within the Free Zone for construction material and equipment to minimize escorting requirements outside of the Free Zone perimeter.

1.10.3.2 Government Responsibilities

a. Security Oversight and vetting.

b. Re-verification of contractor's vetting of employees as US Citizen or US Person status.

c. There will be a chain link fence erected around the entire Free Zone perimeter with a single access point that will be manned during work hours by personnel (Government provided) tracking and validating all access/vehicles/supplies to the construction site with oversight provided by the SSM or authorized Cleared American Guard (CAG) personnel.

d. At the end of each work day the construction site will be checked by the Government to verify all workers have departed and the site access gate will be secured by the Government and randomly checked until the next work day.

e. As required for inspection, the SSM will randomly select materials from general stock for use in construction.

f. The SSM will maintain all site access log information (visitors, workers, security events, access control logs, etc).

1.10.4 Access Within RA, Outside Secure Area Perimeter, no Free Zone

The Government's intent is for minimal work to occur outside of an established Free Zone. Some utility connections and similar activities may necessitate such work. When work inside the RA, but outside of a Free Zone is required, the Contractor shall comply with the following:

1.10.4.1 Contractor Responsibilities

a. Contractor will conduct initial vetting for workers using e-Verify to confirm all workers are US Citizens or US Persons and present a roster of all workers to the Site Security Manager (SSM, Government) who will verify using birth certificate, passport, or I-9 approved identification. Any additional workers added after the initial roster is submitted will not be allowed access until proper vetting has been completed, which may take up to 30 days.

b. After successful validation of US Citizen or US Person status, the validated construction workers will be added to the access control roster, issued a site access badge and receive a security briefing from the SSM. The security badge shall be in the possession of the worker while on site and shall be required for access to any secure or controlled area.

c. All construction workers performing work within the RA perimeter will either be SECRET cleared workers or will be escorted at all times while outside an established Free Zone.

d. Workers will enter the site through the controlled access point only and must be on the controlled access roster provided to the onsite guard. See requirements above regarding controlled access point.

e. No Privately Owned Vehicles (POVs) will be authorized within the RA. Only marked commercial and construction vehicles will be allowed

access - only after validation through the SSM and inspection and checking at the controlled access point. POV parking for workers will be made available in the vicinity of the Project site, outside the RA.

f. All construction equipment entering the Restricted Area will be validated through the SSM.

g. If the contractor has to perform work outside normal working hours, they will coordinate the requirement as prescribed in "Work Outside Regular Hours," above.

h. The contractor shall not stockpile materials outside of an established Free Zone. Materials shall be stockpiled within a nearby Free Zone perimeter and brought to the work activity site to be prepared and/or installed. Materials not installed during the working day shall be returned to an established Free Zone perimeter unless approved by the Contracting Officer.

1.10.4.2 Government Responsibilities

a. Security Oversight and vetting.

b. Re-verification of contractor's vetting of employees as US Citizen or US Person status.

c. The Government will be responsible for direct oversight and escort activities for such work activities, as well as management of the controlled access point managing access to the RA. Government personnel are responsible for tracking and validating allaccess/vehicles/supplies to the work site with oversight provided bythe SSM or authorized Cleared American Guard (CAG) personnel.

d. At the end of each work day the construction site will be checked by the Government to verify all workers have departed and the work site and will be secured by the Government and randomly checked until the next work day.

e. As required for inspection, the SSM will randomly select materials from general stock for use in construction.

f. The SSM will maintain all site access log information (visitors,workers, security events, access control logs, etc).

1.10.5 Requesting New Free Zones within RA

The Government may approve additional free work zones when deemed appropriate for the work activity(ies) and when such a perimeter reduces oversight and escort burdens on the Government and/or Contractor.

If the Contractor wishes to establish a new free work zone, provide appropriate documentation as an amendment to the approved SSAMP not less than 30 calendar days prior to the anticipated start date. The free zone shall not be considered approved until notified as such by the Contracting Officer.

1.11 INFORMATION ACCESS

Contractor access to classified information is prohibited.

1.12 GOVERNMENT PROJECT INSPECTOR

Government Project Inspector will be assigned to each project and will resolve all security issues/problems between the Contractor and Security Forces.

1.13 COMMUNICATIONS SECURITY (COMSEC) MONITORING

Contractor personnel are advised that any time they place a call or receive a call from a DoD organization, they are subject to COMSEC procedures, such as monitoring. All communications with DoD organizations are subject to COMSEC review. Telecommunications networks are continually subject to intercept by unfriendly intelligence organizations. The DoD has authorized the military departments to conduct COMSEC monitoring and recording of telephone calls originating from or termination of DoD organizations. Ensure all contractor employees are informed of the provisions of this paragraph.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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REQUEST FOR VISITOR TO OBTAIN UNESCORTED ACCESS TO BUCKLEY AIR FORCE BASE

PRIVACY ACT

AUTHORITY: Title 10, United States Code 8012
PURPOSE: To assist security personnel in establishing a fitness determination through the identity proofing and vetting (background check) process.
INTENDED USE: To be utilized by personnel requesting to obtain guest installation access credential for unescorted access to Buckley Air Force Base (BAFB).
DISCLOSURE: Disclosure of requested information is voluntary; however, failure to provide information may result in denial of request or the refusal by the 460th Security Forces Squadron, Installation Access Control Section (460th SFS/S3IAC) to permit issuance of an installation access credential. By signing this application, the applicant understands if they lose or misplace their access credential, they will report the loss immediately to their sponsor and the Installation Access Control Section.

INSTRUCTIONS

1. Submit to 460th SFS/S3IAC in person. All information must be completed or the form will be denied.
2. Guest must present government issued photo ID in order to established identity.
3. Sponsor MUST be registered in DBIDS and have a valid DD Form 577 on file prior to submitting form.

SECTION I: SPONSOR

1.1. SPONSOR NAME/ORGANIZATION REPRESENTATIVE (Last, First MI)	1.2. SPONSOR UNIT/ORGANIZATION REPRESENTATIVE CONTACT PHONE
Fattore, Riza P	U.S. Army Corps of Engineers,
1.3. DAYS/HOURS ACCESS REQUIRED	1.4. REASON FOR INSTALLATION ACCESS
Mon-Sat 0600-1800 20220105 - 20230104	Service Repairs at BLDG T1012

SECTION II: SPONSOREE

2.1. NAME (Last, First MI)	2.2. DATE OF BIRTH	2.3. DRIVER LICENSE NUMBER	2.4. STATE OF ISSUE

THIS CERTIFICATION CONCERNS A MATTER WITHIN THE JURISDICTION OF AN AGENCY OF THE UNITED STATES AND THE MAKING OF A FALSE, FICTITIOUS, OR FRAUDULENT CERTIFICATION MAY RENDER THE MAKER SUBJECT TO PROSECUTION UNDER TITLE 18, UNITED STATES CODE, SECTION 1001 OR OTHER APPLICABLE LAWS AND REGULATIONS.

NOTE: "SPONSOR AND/OR GUEST" SHALL RETURN BADGE TO 460TH SFS/S3IAC UPON EXPIRATION.

2.5A. SPONSOR SIGNATURE	2.5B. DATE
2.6A. SPONSOREE SIGNATURE	2.6B. DATE

SECTION III: REQUEST JUSTIFICATION

3.1. DESCRIBE IN DETAIL WHY THE GUEST REQUIRES ACCESS TO BUCKLEY AIR FORCE BASE, TO INCLUDE LENGTH OF DURATION, FPCON CHARLIE JUSTIFICATION AND HOURS OF ACCESS. PLEASE IDENTIFY, BY BUILDING NUMBER, THE BUILDING HE/SHE REQUIRES ACCESS TO. YOUR RECOMMENDATION WILL BE REVIEWED BY THE NCOIC OF INSTALLATION ACCESS CONTROL AND/OR STAFF. THE FINAL DETERMINATION WILL BE MADE WHEN THE GUEST PROCESSES FOR HIS/HER BADGE.

Access to Buckley AFB is requested for the individual listed in Section II above in regards to the ongoing construction project on the installation being administered by the U.S. Army Corps of Engineers, Buckley Resident Office. The duration discussed in cell 1.3 is the anticipated length of time the construction project will be in active construction status (or 1 calendar year whichever is shorter).
The Contractor will need access during the hours of 0600-1800 Monday through Saturday including some federal holidays (no access requested on Thanksgiving, Christmas or New Years Day). The Contractor will be accessing the construction site for the project listed in cell 1.4 above.

SECTION IV: TO BE COMPLETED BY 460TH SECURITY FORCES INSTALLATION ACCESS CONTROL

4.1. NCIC/CCIC CHECK CONDUCTED ON:	4.2. ACCESS GRANTED Buckley AFB ☐ YES ☐ NO FPCON C ☐ YES ☐ NO	4.3. FOREIGN NATIONAL ☐ YES ☐ NO
4.4. DATE ISSUED	4.5. DATE EXPIRES	4.6. DBIDs CARD NUMBER

SECTION V: 460TH SFS INSTALLATION ACCESS CONTROL STAFF

5.1A. SIGNATURE	5.1B. DATE

***ALL SIGNATURE BLOCKS MUST BE SIGNED**
****THIS FORM IS VALID FOR 90 DAYS FROM DATE OF SIGNATURE**

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REQUEST FOR VISITOR TO OBTAIN UNESCORTED ACCESS TO BUCKLEY AIR FORCE BASE

PRIVACY ACT

AUTHORITY: Title 10, United States Code 8012
PURPOSE: To assist security personnel in establishing a fitness determination through the identity proofing and vetting (background check) process.
INTENDED USE: To be utilized by personnel requesting to obtain guest installation access credential for unescorted access to Buckley Air Force Base (BAFB).
DISCLOSURE: Disclosure of requested information is voluntary; however, failure to provide information may result in denial of request or the refusal by the 460th Security Forces Squadron, Installation Access Control Section (460th SFS/S3IAC) to permit issuance of an installation access credential. By signing this application, the applicant understands if they lose or misplace their access credential, they will report the loss immediately to their sponsor and the Installation Access Control Section.

INSTRUCTIONS

1. Submit to 460th SFS/S3IAC in person. All information must be completed or the form will be denied.
2. Guest must present government issued photo ID in order to established identity.
3. Sponsor MUST be registered in DBIDS and have a valid DD Form 577 on file prior to submitting form.

SECTION I: SPONSOR

1.1. SPONSOR NAME/ORGANIZATION REPRESENTATIVE (Last, First MI)	1.2. SPONSOR UNIT/ORGANIZATION REPRESENTATIVE CONTACT PHONE
Fattore, Riza P	U.S. Army Corps of Engineers, 720-692-6264
1.3. DAYS/HOURS ACCESS REQUIRED	1.4. REASON FOR INSTALLATION ACCESS
Mon - Sun 0001 - 2359 20220316 - 20230315, FPCON C	Construction Contractor: ADF Recap #3 (Construction Project)

SECTION II: SPONSOREE

2.1. NAME (Last, First MI)	2.2. DATE OF BIRTH	2.3. DRIVER LICENSE NUMBER	2.4. STATE OF ISSUE

THIS CERTIFICATION CONCERNS A MATTER WITHIN THE JURISDICTION OF AN AGENCY OF THE UNITED STATES AND THE MAKING OF A FALSE, FICTITIOUS, OR FRAUDULENT CERTIFICATION MAY RENDER THE MAKER SUBJECT TO PROSECUTION UNDER TITLE 18, UNITED STATES CODE, SECTION 1001 OR OTHER APPLICABLE LAWS AND REGULATIONS.

NOTE: "SPONSOR AND/OR GUEST" SHALL RETURN BADGE TO 460TH SFS/S3IAC UPON EXPIRATION.

2.5A. SPONSOR SIGNATURE	2.5B. DATE
2.6A. SPONSOREE SIGNATURE	2.6B. DATE

SECTION III: REQUEST JUSTIFICATION

3.1. DESCRIBE IN DETAIL WHY THE GUEST REQUIRES ACCESS TO BUCKLEY AIR FORCE BASE, TO INCLUDE LENGTH OF DURATION, FPCON CHARLIE JUSTIFICATION AND HOURS OF ACCESS. PLEASE IDENTIFY, BY BUILDING NUMBER, THE BUILDING HE/SHE REQUIRES ACCESS TO. YOUR RECOMMENDATION WILL BE REVIEWED BY THE NCOIC OF INSTALLATION ACCESS CONTROL AND/OR STAFF. THE FINAL DETERMINATION WILL BE MADE WHEN THE GUEST PROCESSES FOR HIS/HER BADGE.

Access to Buckley AFB is requested for the individual listed in Section II above in regards to the ongoing construction project on the installation being administered by the U.S. Army Corps of Engineers, Buckley Resident Office. The duration discussed in cell 1.3 is the anticipated length of time the construction project will be in active construction status (or 1 calendar year whichever is shorter).
The Contractor will need access during the hours of 24/7 Monday through Sunday including all federal holidays. Due to the critical infrastructure the Contractor will be working on. FPCON Charlie access is also requested due to the critical infrastructure this Contractor will be working on. The Contractor will be accessing the construction site for the project listed in cell 1.4 above.

SECTION IV: TO BE COMPLETED BY 460TH SECURITY FORCES INSTALLATION ACCESS CONTROL

4.1. NCIC/CCIC CHECK CONDUCTED ON:	4.2. ACCESS GRANTED	4.3. FOREIGN NATIONAL
	Buckley AFB ☐ YES ☐ NO FPCON C ☐ YES ☐ NO	☐ YES ☐ NO
4.4. DATE ISSUED	4.5. DATE EXPIRES	4.6. DBIDs CARD NUMBER

SECTION V: 460TH SFS INSTALLATION ACCESS CONTROL STAFF

5.1A. SIGNATURE	5.1B. DATE

***ALL SIGNATURE BLOCKS MUST BE SIGNED**
****THIS FORM IS VALID FOR 90 DAYS FROM DATE OF SIGNATURE**

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REQUEST FOR VISITOR TO OBTAIN UNESCORTED ACCESS TO BUCKLEY AIR FORCE BASE

PRIVACY ACT

AUTHORITY: Title 10, United States Code 8012
PURPOSE: To assist security personnel in establishing a fitness determination through the identity proofing and vetting process.
INTENDED USE: To be utilized by personnel requesting to obtain guest installation access pass for unescorted access to Buckley Air Force Base (BAFB) for 1-30 days or for special one time events.
DISCLOSURE: Disclosure of requested information is voluntary; however, failure to provide information may result in denial of request or the refusal by the 460th Security Forces Squadron, Installation Access Control Section to permit access to the installation.

INSTRUCTIONS

1. All information must be complete and in alphabetical order or the form will be denied.
2. Guest must present government/state ID in order to establish identity.
3. Sponsor must be registered in DBIDS prior to submitting form.
4. Must be submitted to Access Control Staff 72 hours prior to request.

SECTION I: SPONSOR INFORMATION

SPONSOR NAME (Last, First MI)	SPONSOR UNIT/CONTACT PHONE NUMBER
Fattore, Riza P	U.S. Army Corps of Engineers, 720-692-6264
DURATION OF REQUEST (MMDDYY-MMDDYY)	REASON FOR VISIT

SECTION II: GUEST INFORMATION

GUEST NAME (Last, First MI)	DOB (MMDDYY)	DRIVERS LICENSE NUMBER	ST	ACCESS - YES/NO
				YES
				YES
				YES

SECTION III: TO BE COMPLETED BY 460TH SECURITY FORCES INSTALLATION ACCESS CONTROL STAFF

NCIC CHECK CONDUCTED ON	APPROVING OFFICIAL (Last, First MI)	SIGNATURE

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OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS

09/23

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3.1 APPENDIX A- CONTRACT DOCUMENT DISTRIBUTION LIST

ATTACHMENTS:

Appendix A - Contract Document Distribution List

Project Sign Details

AF103 - Base Civil Engineering Work Clearance Request

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OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS
09/23

PART 1 GENERAL

Attachments:
Appendix A - Contract Document Distribution List
Project Sign Details
AF103 - Base Civil Engineering Work Clearance Request

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-300-08	(2023) Criteria for Transfer and Acceptance of DoD Real Property

1.2 EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE

In accordance with FAR 31.105(d)(2)(i)(b), for the predetermined schedule of construction equipment use rates, use Engineer Pamphlet (EP) 1110-1-8, Construction Equipment Ownership and Operating Expense Schedule. Copies of each regional schedule may be obtained through the following internet site:

https://www.usace.army.mil/Cost-Engineering/EP1110-1-8/.

1.3 CONTRACTOR SUPPLY AND USE OF ELECTRONIC SOFTWARE FOR PROCESSING CONSTRUCTION WAGE RATE REQUIREMENTS STATUTE CERTIFIED LABOR PAYROLLS

a.Use a commercially-available electronic system to process and submit certified payrolls electronically to the Government. The requirements for preparing, processing and providing certified labor payrolls are established by the Wage Rate Requirements statute.

b. Obtain and provide for all access, licenses, and other services required to provide for receipt, processing, certifying, electronically transmitting to the Government, and storing weekly payrolls and other data required for the Contractor to comply with the Wage Rate Requirements statute. Use the electronic payroll service to prepare, process, and maintain the relevant payrolls and basic records during all work under this construction contract. Use an electronic payroll service capable of preserving these payrolls and related basic records for the required three years after contract completion. Obtain and provide electronic system access to the Government, as required to comply with the Wage Rate

Requirements over the duration of the construction contract.

The Contractor's provision and use of an electronic payroll processing system must meet the following basic functional criteria:

(1) commercially available;

(2) compliant with appropriate Wage Rate Requirements statute payroll provisions in the FAR;

(3) able to accommodate the required numbers of employees and subcontractors planned to be employed under the contract;

(4) capable of producing an Excel spreadsheet-compatible electronic output of weekly payroll records for export into an Excel spreadsheet to be imported into the contractor's mode of Resident Management System 3.0;

(5) demonstrated security of data and data entry rights;

(6) ability to produce Contractor-certified electronic versions of weekly payroll data;

(7) ability to identify erroneous entries and track the data/time of all versions of the certified Wage Rate Requirements statute payrolls submitted to the government over the life of the contract;

(8) capable of generating a durable record copy in a Compact Disc (CD) or Digital Versatile Disc (DVD) and Portable Document Format (PDF) file record of data from the system database at the end of the contract closeout. Provide this durable record copy of data from the electronic payroll processing system to the Government during contract closeout.

d. Include all Contractor-incurred costs related to the Contractor's provision and use of an electronic payroll processing service in the Contractor's price for the overall work under the contract. Do not include the costs for compliance with the Wage Rate Requirements statute by using electronic payroll processing services as a separately bid or reimbursed item under this contract.

1.4 VETERANS EMPLOYMENT EMPHASIS FOR U.S. ARMY CORPS OF ENGINEERS CONTRACTS

In addition to complying with the requirements outlined in FAR Part 22.13, FAR Provision 52.222-38, FAR Clause 52.222-35, FAR Clause 52.222-37, DFARS 222.13 and Department of Labor regulations, U.S. Army Corps of Engineers (USACE) contractors and subcontractors at all tiers are encouraged to promote the training and employment of U.S. veterans while performing under a USACE contract. While no set-aside, evaluation preference, or incentive applies to the solicitation or performance under the resultant contract, USACE contractors are encouraged to seek out highly qualified veterans to perform services under this contract. The following resources are available to assist USACE contractors in their outreach efforts:

- U.S. Department of Labor Veterans’ Employment and Training Service (VETS):
https://www.dol.gov/vets/
- Federal Veteran Employment Information: https://www.fedshirevets.gov/
- Veterans Opportunity to Work (VOW) Program:
https://www.benefits.va.gov/vow/
- U.S. Army Warrior Transition Command Employment Index:

https://wct.army.mil/modules/employers/index.html
- Hiring Our Heroes: https://www.uschamberfoundation.org/hiring-our-heroes

1.5 CONTRACTOR PERFORMANCE EVALUATIONS

See Federal Acquisition Regulation (FAR) Subpart 42.1502(e) for the requirements on past performance evaluations for construction contracts.For construction contracts valued at or above $750,000.00, including all modifications, the USACE will evaluate Contractor's performance using the web-based Contractors Performance Assessment Reporting System (CPARS). After the USACE drafts an evaluation (interim or final), the Contractor will have the opportunity to access, review, comment and either concur or non-concur with the evaluation in the CPARS system for a period of 60 days. Access to the CPARS system requires either specific software called PKI certification (recommended method) or a username and password. The PKI certification is a Department of Defense recommendation and to provide security in electronic transactions. The certification software could cost approximately $110 - $125 per certificate per year and may be purchased from an External Certificate Authorities (ECA) vendor. Current information about the PKI certification process and contacting vendors can be found on the web site: https://www.cpars.gov.

1.6 EXCEPTION TO COMPLETION TIME AND LIQUIDATED DAMAGES

In case the Contracting Officer determines that seeding, sodding, and/or planting and/or the specified maintenance thereof is not feasible during the construction period, such work will be exempt from the completion time and liquidated damages. Accomplish this work during the first seeding, sodding, and/or planting period and the specified maintenance period following the completion date.

1.7 MISSION DELAY DAYS

a. During construction, the function of the site may prohibit construction activities to occur for a period of a day or consecutive days. Plan on the following when developing the project construction schedule:
    (1) Six delay days per 12-month period.
b. Mission delay days are non-compensatory days.
c. If the number of actual mission delay days exceeds the number of days listed above, the Contracting Officer will issue a contract modification for additional time that is non-compensatory.

1.8 CONTRACT DRAWINGS AND SPECIFICATIONS

1.8.1 SETS FURNISHED

Make copies of conformed specifications with amendments or changes incorporated. Utilize the bid drawings and specifications as amended in the performance of the work until the conformed specifications and contract drawings (i.e., bid drawings that have been posted with all amendment changes) are mailed or sent electronically to the Contractor. See Appendix A for Document Distribution list. See paragraph below for contract drawing reproduction and distribution requirements. Ensure the work conforms to the contract drawings, set out in the drawing index, all of which form a part of these specifications. Also ensure the work conforms to any of the standard details bound or referenced herein.

1.8.2 REPRODUCTION AND DISTRIBUTION

Reproduce multiple legible hard copy sets (half-size English unless directed otherwise) of contract drawings consisting of read-only Adobe Acrobat.pdf file drawings. Within 14 calendar days after receipt of conformed specifications and drawings, provide legible hard copy drawing and conformed specification sets to the addressees contained in the Contract Document Distribution List for Project in Appendix A to this specification. The Government will process no progress payments prior to receipt of the legible contract drawings and conformed specification sets. After receipt and distribution of the legible hard copy drawing and conformed specification sets, the Government will provide the Contractor with editable CAD file drawings (format defined in Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS). Prepare as-built drawings as defined in Section 01 78 39.00 24 AS-BUILT DRAWINGS.

1.8.3 NOTIFICATION OF DISCREPANCIES

Check all drawing files furnished by the Government immediately upon their receipt and promptly notify the Contracting Officer of any discrepancies. Follow dimensions marked on drawings in lieu of scale measurements. Enlarged plans and details govern where the same work is shown at smaller scales. All scales shown are based on a standard drawing size of 22" x 34". If any other size drawings are furnished or plotted adjust the scales accordingly. Advise sub-contractors of the above. Compare all drawings and verify the figures before laying out the work and take responsibility for any errors which might have been avoided thereby.

1.8.4 OMISSIONS

Omissions from the drawings or specifications or the misdescription of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, does not relieve the Contractor from performing such omitted or misdescribed details of the work. Perform as if fully and correctly set forth and described in the drawings and specifications.

1.9 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit items below in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

List Of Contact Personnel

VIEW LOCATION MAP

PROGRESS AND COMPLETION PICTURES

SD-02 Shop Drawings

Equipment Room Drawings; G-RO.

SD-11 Closeout Submittals

Interim DD Form 1354; G, RO

List Of Installed Building Equipment Items For Dd Form 1354

1.10 CONCURRENT CONSTRUCTION

Construction work closely related to and/or located at the site of the work under a concurrent contract, including Replacement Water Well, Redundant Electrical Supply, and Bldg 430 may will be in progress simultaneously with work under this contract. Cooperate with others as necessary in the interest of timely completion of all work. In the event of interference, notify the Contracting Officer (CO) immediately for resolution and the CO decision will be final.

1.11 PAYMENT

1.11.1 PROMPT PAYMENT ACT

Pay requests authorized in GENERAL CONDITIONS (CONTRACT CLAUSES) clause: "Payments Under Fixed-Price Construction Contracts", will be paid pursuant to the clause, "Prompt Payment for Construction Contracts". Submit pay requests on ENG Form 93 and 93a, "Payment Estimate-Contract Performance" and "Continuation". All information and substantiation required by the identified contract clauses must be submitted with the ENG Form 93, and the required certification included on the last page of the ENG Form 93a, signed by an authorized contractor official and dated when signed. The designated billing office is the Office of the Area Engineer.

1.11.2 PAYMENT FOR MATERIALS STORED OFFSITE

a. As allowed under (FAR) 52.232-5 "Payments Under Fixed Price Construction Contracts", the Administrative Contracting Officer, at their discretion, may authorize progress payments for any material stored off-site provided:

(1) The Contractor furnishes satisfactory evidence that it has acquired title to such material and that the material will be used to perform this contract,

(2) Material is stored in such a manner to protect it from damage, fire, theft, etc.

(3) The Contractor provides evidence of insurance for material, and,

(4) Material is clearly identified and delineated by contract number for use on the applicable project.

b. The Administrative Contracting Officer reserves the right to inspect any off-site material prior to authorizing progress payments. Provide paid invoices listing the value of material and labor incorporated in the items.

1.11.3 CONTRACTOR PAYROLL RECORD

Log payrolls for all employees and subcontractors utilizing ENG Form 3180. Each subcontractor requires a separate ENG 3180 for their payrolls. Maintain the ENG 3180, along with the payrolls, on site and make available for review by the Contracting Officer's Representative. Update the ENG 3180's weekly as payrolls are submitted. After making

copies for their files, submit the originals of each week’s payrolls to the Resident Office. Before final payment, provide the completed ENG 3180’s to the Contracting Officer's Representatives. If the Contractor has elected to use an electronic payroll system, as described in paragraph CONTRACTOR SUPPLY AND USE OF ELECTRONIC SOFTWARE FOR PROCESSING CONSTRUCTION WAGE RATE REQUIREMENTS STATUTE CERTIFIED LABOR PAYROLLS, the payroll inventory produced by the electronic payroll system will satisfy the requirements in this paragraph and FAR 52.222-8, Payrolls and Basic Records.

1.12 AVAILABILITY OF UTILITY SERVICES

The Government will make available all reasonably required amounts of domestic water and electricity used for construction of this project and to make final tests of the completely installed items to the Contractor from existing system outlets and supplies without charge. Limit use of utilities to what is needed to perform work. The Government will not allow the charging of electric vehicles owned or operated by the Contractor or subcontractors at Government charging stations. The Contractor is responsible to, at their own expense, make all temporary connections and install distribution lines. Furnish to the Contracting Officer a complete system layout drawing showing type of materials to be used and method of installation for all temporary connections. Install meters to determine the amount of water and electricity used by the Contractor. Maintain all temporary lines in a workmanlike manner satisfactory to the Contracting Officer and remove in like manner prior to final acceptance of the construction. The Government will furnish normal quantities of electricity and water needed to make final tests of completely installed systems.

1.12.1 Utility Meters

Equip all connections with appropriate utility meters complying with associated utility meter requirements defined in this Contract. Furnish and install approved metered reduced pressure backflow prevention assemblies on all connections to domestic water lines in a manner that does not contaminate or impact operation of base-wide water supply as specfified below. Provide access to and readings for utility usage to the Government for accountability and recordkeeping. Meters on temporary connections will remain the property of the Contractor after disconnect.

1.13 UTILITY SERVICE INTERRUPTIONS

Submit written notification not less than 15 calendar days in advance of each interruption of each utility and communication service to or within existing buildings and facilities being used by others. No single outage will exceed 4 hours unless approved in writing. The time and duration of all outages will be coordinated and approved with the Using Agency by the Contracting Officer.

1.14 DIGGING PERMITS AND ROAD CLOSINGS

Allow 14 calendar days from date of written application to receive permission to dig and to close roads. Only close roads one lane at a time and allow vehicular traffic to pass through the construction area. Flag work in accordance with the safety requirements in Safety and Health Requirements Manual EM 385-1-1, which forms a part of these specifications. Do not cause blockage of work along the alert force route and maintain unobstructed access for alert force traffic at all times.

1.15 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER

a. This provision specifies the procedure for the determination of time extensions for unusually severe weather in accordance with FAR 52.249-10 "Default: (Fixed-Price Construction)." In order for the Contracting Officer to award a time extension under this clause, the following conditions must be satisfied:

(1) The weather experienced at the project site during the contract period must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month.

(2) The unusually severe weather must actually cause a delay to the completion of the project. The delay must be beyond the control and without the fault or negligence of the contractor.

b. The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the project location and will constitute the base line for monthly weather time evaluations. The Contractor's progress schedule must reflect these anticipated adverse weather delays in all weather dependent activities.

MONTHLY ANTICIPATED ADVERSE WEATHER DELAY
WORK DAYS BASED ON (5) DAY WORK WEEK

Jan	5
Feb	5
Mar	3
Apr	4
May	3
Jun	4
Jul	3
Aug	3
Sep	2
Oct	3
Nov	3
Dec	7

c. Upon acknowledgment of the Notice to Proceed (NTP) and continuing throughout the contract, the contractor will record on the RMS daily CQC report, any occurrence of adverse weather and resultant impact to normally scheduled work, within 24 hours of the event. Actual adverse weather delay days must prevent work on critical activities for 50 percent or more of the contractor's scheduled work day. Describe in the RMS daily CQC reports the critical path item that is being affected and provide the critical path activity number(s) from the current schedule. The COR must acknowledge and accept the agreed upon occurrence of each adverse weather delay in RMS for the delays to be considered as adverse weather delays.

At the end of each month, identify the number of actual adverse weather delay days that includes days impacted by actual adverse weather (even if adverse weather occurred in previous month), calculated chronologically from the first to the last day of each month, and recorded as full days. If the number of actual adverse weather delay days exceeds the number of days anticipated in paragraph b. above, the Contracting Officer will convert any qualifying delays to calendar days, giving full consideration

for equivalent fair weather work days, and issue a modification in accordance with the GENERAL CONDITIONS (CONTRACT CLAUSES) clause entitled "Default (Fixed Price Construction)". (ER 415-1-15)

1.16 VIEW LOCATION MAP

Submit, prior to or with the first digital photograph submittals, a sketch or drawing indicating the required photographic locations. Update as required if the locations are moved.

1.17 PROGRESS AND COMPLETION PICTURES

Photographically document site conditions prior to start of construction operations. Provide monthly, and within one month of the completion of work, digital photographs, 1600x1200x24 bit true color minimum resolution in JPEG file format showing the sequence and progress of work. Take a minimum of 20 digital photographs each week throughout the entire project from a minimum of ten different viewpoints selected by the Contractor unless otherwise directed by the Contracting Officer. Submit with the monthly invoice two sets of digital photographs, each set on a separate compact disc (CD) or data versatile disc (DVD), cumulative of all photos to date. Indicate photographs demonstrating environmental procedures. Provide photographs for each month in a separate monthly directory and name each file to indicate its location on the view location sketch. Also provide the view location sketch on the CD or DVD as a digital file. Include a date designator in file names. Photographs provided are for unrestricted use by the Government.

1.18 INSURANCE REQUIRED

In accordance with GENERAL CONDITIONS (CONTRACT CLAUSES) clause: "Insurance Work on a Government Installation," procure the following minimum insurance:

Type	Amount
Workmen's Compensation and Employer's Liability Insurance	$100,000
General Liability Insurance	$500,000 per occurrence
Automobile Liability Insurance	
Bodily injury	$200,000 per person and $500,000 per occurrence
Property damage	$ 20,000 per occurrence

(Coverages per FAR 28.307-2)

1.19 SUPERVISION

1.19.1 Superintendent Qualifications

Provide project superintendent with a minimum of 10 years experience in construction with at least 5 of those years as a superintendent on projects similar in size and complexity. The individual must be familiar with the requirements of EM 385-1-1 and have experience in the areas of hazard identification and safety compliance. The individual must be capable of interpreting a critical path schedule and construction drawings. The qualification requirements for the alternate superintendent

are the same as for the project superintendent. The Contracting Officer may request proof of the superintendent's qualifications at any point in the project if the performance of the superintendent is in question.

1.19.2 Minimum Communication Requirements

Have at least one qualified superintendent, or competent alternate, capable of reading, writing, and conversing fluently in the English language, on the job-site at all times during the performance of Contract work. In addition, if a Quality Control (QC) representative is required on the Contract, then that individual must also have fluent English communication skills.

1.19.3 Duties

The project superintendent is primarily responsible for managing subcontractors and coordinating day-to-day production and schedule adherence on the project. The superintendent is required to attend Red Zone meetings, partnering meetings, and quality control meetings. The superintendent or qualified alternative must be on-site at all times during the performance of this contract until the work is completed and accepted.

1.19.4 Non-Compliance Actions

The Project Superintendent is subject to removal by the Contracting Officer for non-compliance with requirements specified in the contract and for failure to manage the project to ensure timely completion. Furthermore, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders is acceptable as the subject of claim for extension of time for excess costs or damages by the Contractor.

1.20 PRECONSTRUCTION CONFERENCE

Immediately after award, prior to commencing any work at the site, coordinate with the Contracting Officer a time and place to meet for the Preconstruction Conference. The conference must take place within 35 calendar days after award of the contract, but prior to commencement of any work at the site. The purpose of this conference is to discuss and develop a mutual understanding of the administrative requirements of the Contract including but not limited to: daily reporting, invoicing, value engineering, safety, base-access, outage requests, hot work permits, schedule requirements, quality control, schedule of prices or earned value report, shop drawings, submittals, cybersecurity, prosecution of the work, government acceptance, final inspections and contract close-out. Contractor must present and discuss their basic approach to scheduling the construction work and any required phasing.

1.20.1 Attendees

Contractor attendees must include the Project Manager, Superintendent, Site Safety and Health Officer (SSHO), Quality Control Manager and major subcontractors.

1.21 FACILITY TURNOVER PLANNING MEETINGS (Red Zone Meetings)

Meet with the Government to identify strategies to ensure the project is

carried to expeditious closure and turnover to the Client. Start planning the turnover process at the Pre-Construction Conference meeting with a discussion of the Red Zone process and convene at regularly scheduled NAVFAC Red Zone Meetings beginning at approximately 75 percent of project completion. Include the following in the facility Turnover effort:

1.21.1 Red Zone Checklist

a. Contracting Officer's Technical Representative (COTR) will provide the Contractor a copy of the Red Zone Checklist template.

b. Prior to 75 percent completion, modify the Red Zone Checklist template by adding or deleting critical activities applicable to the project and assign planned completion dates for each activity. Submit the modified Red Zone Checklist to the Contracting Officer. The Contracting Officer may request additional activities be added to the Red Zone Checklist at any time as necessary.

1.21.2 Meetings

a. Conduct regular Red Zone Meetings beginning at approximately 75 percent project completion, or three to six months prior to Beneficial Occupancy Date (BOD), whichever comes first.

b. The Contracting Officer will establish the frequency of the meetings, which is expected to increase as the project completion draws nearer. At the beginning, Red Zone meetings may be every two weeks then increase to weekly towards the final month of the project.

c. Using the Red Zone Checklist as a Plan of Action and Milestones (POAM) and basis for discussion, review upcoming critical activities and strategies to ensure work is completed on time.

d. During the Red Zone Meetings discuss with the COTR any upcoming activities that require Government involvement.

e. Maintain the Red Zone Checklist by documenting the actual completion dates as work is completed and update the Red Zone Checklist with revised planned completion dates as necessary to match progress. Distribute copies of the current Red Zone Checklist to attendees at each Red Zone Meeting.

1.22 SECURITY REQUIREMENTS

1.22.1 Contractor's Employee Identification

The Contractor is responsible for furnishing to each employee and for requiring each employee engaged on the work to display such identification as may be approved and directed by the Contracting Officer. Upon relase of any employees, deliver all prescribed identification immediately to the Contracting Officer for cancellation. When the contract involves work in restricted security areas, only employees who are U.S. citizens will be permitted to enter. Proof of U.S. citizenship is required prior to entry. When required by the Contracting Officer, obtain and submit fingerprints of all persons employed or to be employed on the project. (Based on FAR 52.204-2)

1.22.2 Activity Regulations

Ensure that Contractor personnel employed on the Activity become familiar with and obey Activity regulations including safety, fire, traffic and security regulations. Keep within the limits of the work and avenues of ingress and egress. Wear appropriate personal protective equipment (PPE) in designated areas. Do not enter any restricted areas unless required to do so and until cleared for such entry. Ensure all Contractor equipment, include delivery vehicles, are clearly identified with their company name.

1.22.2.1 Subcontractors and Personnel Contacts

Provide a list of contact personnel of the Contractor and subcontractors including addresses and telephone numbers for use in the event of an emergency. As changes occur and additional information becomes available, correct and change the information contained in previous lists.

1.22.2.2 No Smoking Policy

Smoking is prohibited within and outside of all buildings on installation, except in designated smoking areas. This applies to existing buildings, buildings under construction and buildings under renovation. Discarding tobacco materials other than into designated tobacco receptacles is considered littering and is subject to fines. The Contracting Officer will identify designated smoking areas.

1.22.3 Entry Requirements

See Section 01 14 00 WORK RESTRICTIONS.

1.23 CONTRACTOR QUALITY CONTROL (CQC)

See Section 01 45 00 QUALITY CONTROL.

1.24 NONDOMESTIC CONSTRUCTION MATERIALS

The list of excepted nondomestic construction materials or their components referenced in the Buy American Construction Material Contract Clauses includes the list set forth in paragraph 25.104 of the Federal Acquisition Regulation.

1.25 DAILY WORK SCHEDULES AND WEEKLY COORDINATION MEETINGS

In order to closely coordinate work under this contract, prepare a written agenda/meeting minutes and attend a weekly coordination meeting with the Contracting Officer and Using Service. Submit written agenda/meeting minutes and proposed daily work schedule for the next two week period for coordination and approval. Provide a copy of modifications (MODs), Serial Letters, Requests for Information (RFIs) and any other information that is needed in the minutes of the meeting. Include required temporary utility services, time and duration of interruptions, and protection of adjoining areas with the Contractor's proposed 2-week work schedule. At this meeting, also submit a schedule of proposed dates and times of all preparatory inspections to be performed during the next two weeks. Develop all schedules in accordance with Section 01 32 01.00 10 PROJECT SCHEDULE . Accomplish coordination action by the Contracting Officer relative to these schedules during these weekly meetings. Complete and give daily reports to the Contracting Officer or Representative within 24 hours of work. Provide all official correspondence such as serial letters and

RFIs, with attachments in one hardcopy original with original signatures and one electronic (Adobe pdf format) copy by email. The Government will consider the correspondence to be received when the official hardcopy or electronic copy is received by the designated office.

1.26 AS-BUILT DRAWINGS

See SECTION 01 78 39.00 24 - AS-BUILT DRAWINGS

1.27 SIGN

On commencement of work on this project, the Contractor shall furnish and erect the temporary sign in the location selected by the Contracting Officer near the project site. Maintain the sign in good condition through the project construction period. Upon completion of the project remove the sign from the premises. Ensure the project sign conforms to standard drawing attached to this section. The Government will furnish a decal of the "Engineer Castle" and the U. S. Air Force emblem to the Contractor upon request.

1.28 GOVERNMENT-FURNISHED PROPERTY

Pursuant to CONTRACT CLAUSES clause: "Government Property " the Government will furnish to the Contractor the following property to be incorporated or installed in the work. Accept delivery when made, and unload and transport the property to the jobsite at the Contractor's expense. Install or incorporate into the work all such property at the expense of the Contractor. Verify the quantity and condition of such Government-furnished property when delivered and report the receipt of Government-Furnished Property in accordance with DFARS 252.211-7007 REPORTING OF GOVERNMENT-FURNISHED PROPERTY. For damage or loss or property follow DFARS 252.245-7002 REPORTING LOSS OF GOVERNMENT PROPERTY.

Quantity	Item	Description

None identified.

1.29 EQUIPMENT ROOM DRAWINGS

Prior to construction, prepare and submit room plans for all mechanical, electrical, and communication rooms or similar areas. Consolidate plans for all trades, ensure plans are to scale, and show all pertinent structural features. In addition, show other items such as doors, windows, and cabinets required for installation and which will affect the available space. Show all mechanical and electrical equipment and accessories to scale in plan and elevation and/or section in their installed positions. Show all duct work and piping.

1.30 CONTRACTOR FURNISHED EQUIPMENT DATA

See Section 01 78 36.00 24 WARRANTY OF CONSTRUCTION for Contractor Furnished Equipment Data to be submitted as part of the Warranty Equipment Booklet.

1.31 ASBESTOS AND LEAD

a. The Contractor is warned that inhalation of asbestos and lead has been associated with health hazards.

b. Asbestos-containing materials may be present in area(s) where contract work is to be performed. Perform all contract work activities where the potential exists for worker exposure to airborne asbestos fibers in accordance with the requirements set forth in Section 02 82 00 ASBESTOS REMEDIATION.

c. Lead may be present in some painted surfaces which are scheduled for removal/renovation. See Section 02 83 00 LEAD REMEDIATION for additional information and proper procedures.

1.32 PARTNERING

To most effectively accomplish this Contract, the Contractor and Government must form a cohesive partnership with the common goal of drawing on the strength of each organization in an effort to achieve a successful project without safety mishaps, conforming to the Contract, within budget and on schedule. The partnering team must consist of personnel from both the Government and Contractor including project level and corporate level leadership positions. Key Personnel from the supported command, end user, Contractor, key subcontractors and the Designer of Record are required to participate in the Partnering process.

1.32.1 Facilitated (Formal) Partnering

a. Within 45 calendar days after award and prior to the start of work, or as coordinated with and approved by the Government, host a Formal Partnering session with key personnel from the project team including both Contractor and Government personnel. All costs associated with the Partnering session including the third-party independent Facilitator Consultant, meeting room and other incidental items are the responsibility of the Contractor.

b. Before the Facilitated (Formal) Partnering session, coordinate with the Facilitator all requirements for incidental items (such as audio-visual equipment, easels, flipchart paper, colored markers, note pads, pens/pencils, colored flash cards) and have these items available at the Partnering session. Provide copies of any documents required for distribution to all attendees. Participants will bear their own costs for meals, lodging and transportation associated with Partnering.

c. The Initial Partnering Session must be a duration of one day and be held at a location off base as agreed to by the Contracting Officer. Partnering session may take place concurrently with the Pre-Construction Meeting.

d. Facilitator must be experienced in conducting corporate Partnering sessions and must be a third-party independent facilitating consultant - not an employee of the Contractor. The Facilitator is responsible for leading all aspects of the Partnering session necessary to achieve the Partnering goal.

e. An outcome of the Partnering session must be an escalation matrix agreed upon by both the Government and Contractor, which identifies key Government and Contractor decision makers by name and anticipated decision durations.

f. Host follow-on Partnering Sessions at three- to six-month intervals or more frequently if needed and lasting generally a half day or less.

Attendees need only be those required to resolve current issues. The same Facilitator used in the Initial Partnering session must lead the follow-on sessions unless an alternative is permitted by the Contractor Officer. All costs associated with follow-on Partnering sessions are the responsibility of the Contractor.

1.33 PROFIT

a. Use the weighted guidelines method of determining profit on any equitable adjustment change order or modification issued under this contract. The profit factors are as follows:

Factor	Rate	Weight	Value
Degree of Risk	20	See Item	
Relative difficulty of work	15	b. below	
Size of Job	15		
Period of performance	15		
Contractor's investment	5		
Assistance by Government	5		
Subcontracting	25		
	100		

b. Based on the circumstances of each procurement action, weight each of the above factors from .03 to .12 as indicated below. Obtain the value by multiplying the rate by the weight. The value column when totaled indicates the fair and reasonable profit percentage under the circumstances of the particular procurement.

(1) Degree of Risk. Where the work involves no risk or the degree of risk is very small, the weighting should be .03; as the degree of risk increases, the weighting should be increased up to a maximum of .12. Lump sum items will have, generally, a higher weighted value than the unit price items for which quantities are provided. Other things to consider: the portion of the work to be done by subcontractors, nature of work, where work is to be performed, reasonableness of negotiated costs, amount of labor included in costs, and whether the negotiation is before or after performance of work.

(2) Relative Difficulty of Work. If the work is most difficult and complex, the weighting should be .12 and should be proportionately reduced to .03 on the simplest of jobs. This factor is tied in to some extent with the degree of risk. Some things to consider: the nature of the work, by whom it is to be done, where, and what is the time schedule.

(3) Size of Job. All work not in excess of $100,000 shall be weighted at .12. Work estimated between $100,000 and $5,000,000 shall be proportionately weighted from .12 to .05.

(4) Periods of Performance. Jobs in excess of 24 months are to be weighted at .12. Jobs of lesser duration are to be proportionately weighted to a minimum of .03 for jobs not to exceed 30 days. No weight where additional time not required.

(5) Contractor's Investment. To be weighted from .03 to .12 on the basis of below average, average, and above average. Things to consider: amount of subcontracting, mobilization payment item, Government furnished property, equipment and facilities, and expediting assistance.

(6) Assistance by Government. To be weighted from .12 to .03 on

the basis of average to above average. Things to consider: use of Government-owned property, equipment and facilities, and expediting assistance.

(7) Subcontracting. To be weighted inversely proportional to the amount of subcontracting. Where 80 percent or more of the work is to be subcontracted, the weighting is to be .03 and such weighting proportionately increased to .12 where all the work is performed by the Contractor's own forces.

1.34 LABOR CONDITIONS APPLICABLE TO TEMPORARY FACILITIES

It is the position of the Department of Defense that the Davis-Bacon Act, 40 U.S.C. 276a is applicable to temporary facilities such as job headquarters, tool yards, batch plants, borrow pits, sandpits, rock quarries, and similar operations, provided they are dedicated exclusively, or nearly so, to performance of the contract or project, and provided they are adjacent or virtually adjacent to the site of the work and are established after receipt of the proposal or bid. Clause "Payrolls and Basic Records" of the GENERAL CONDITIONS (CONTRACT CLAUSES) is applicable to such operations.

1.35 DRAWING SCALES

All scales shown are based on a standard drawing size of 22" x 34". If any other size drawings are furnished or plotted, adjust the scales accordingly. Advise sub-contractors of the above.

1.36 FEDERAL HOLIDAYS

The following Federal legal holidays are observed by this installation:

New Year's Day	1 January
Martin Luther King's Birthday	Third Monday in January
President's Day	Third Monday in February
Memorial Day	Last Monday in May
Juneteenth	19 June
Independence Day	4 July
Labor Day	First Monday in September
Columbus Day	Second Monday in October
Veterans Day	11 November
Thanksgiving Day	Fourth Thursday in November
Christmas Day	25 December

If a wage determination applies the number of holidays specified on it, it has priority over this requirement.

1.37 BASE HOURS

Base operation hours outside of the Restricted Area (RA) are 6:00 a.m. to 6:00 p.m. daily (Monday through Friday), excluding federal holidays. Access to the base during other times must be requested in writing from the Contracting Officer and will be granted only for extenuating circumstances. Federal Holidays and weekends are considered as scheduled non-workdays.

See Section 01 14 00 WORK RESTRICTIONS for regular working hours within the RA.

1.38 COST AND TIME IMPACT (CTI) LOG

a. Any changes with an absolute value under the Simplified Acquisition Threshold (SAT) at the time of initiation of the change and within the Administrative Contracting Officer's (ACO) authority, may be executed using the Cost and Time Impact Log (CTI Log) processes as described herein. The purpose of the CTI Log is to provide efficient and effective change management process for the mutual benefit of the Government and the Contractor while partnering to execute this contract.

b. The CTI Log process is a collaborative, proactive, and efficient change management process. In general, the CTI Log process is as described below.

1. The CTI Log is designated for use on work items determined to be changes where individual costs are anticipated to be less than the SAT. The process starts with a discussion between USACE on-site Contracting Officer's Representative (COR) or ACO and the prime contractor's authorized field representative. If it appears the issue cannot be resolved through a no-cost clarification of the contract requirements, the USACE COR will request the contractor to submit a confirming Request for Information (RFI). Where the solution to the problem is not apparent and not initially resolvable at the field level, the Contractor may submit to USACE a “non-confirming” RFI and USACE shall provide technical direction. If the absolute value of the change is anticipated to exceed the SAT, the contractor will be advised that a Request for Proposal (RFP) for the change will be forthcoming and that the CTI Log process shall not be utilized.

2. The contractor submits the confirming RFI identifying the potential Cost and/or Time impact issue as previously discussed between the USACE COR and the contractor's field representative, along with a proposed solution. In addition to the technical details, the RFI shall contain, to the maximum extent practicable, a proposal for the change from the contractor with an acceptable breakdown of all costs (representing both the prime and each of the applicable subcontractors' costs) to include labor, equipment and material. Time impacts, if applicable, must include a Time Impact Analysis (TIA) of work activities. The prime and subcontractor(s) will provide their markups for each of the individual changes as they arise, to include profit development in accordance with (IAW) the alternate Weighted Profit Guidelines approach per UAI 5115.404-73. If mutually agreed upon by both the Government and Contractor, the Contractor may submit the confirming RFI without the detailed cost proposal and/or the Time Impact Analysis, but shall contain a ROM of cost impacts and time impacts. If it is mutually agreed that the Contractor’s cost proposal and TIA may not be included in the confirming RFI, the Contractor shall submit both the proposal and TIA as soon as practicable or by the date specified in the Government’s response to the RFI, whichever is sooner.

3. If the proposal and TIA are included in the RFI from the Contractor, the Government shall evaluate the Contractor’s technical recommendation in the RFI, the Contractor’s proposal, and the TIA. When the technical solution is determined and any

cost and/or time impacts are discussed, negotiated (if necessary), and determined to be fair and reasonable, the Government ACO will return the RFI with the technical solution and note that the formal price and time agreement will be captured on the CTI Log. Under no circumstances will the RFI response act as a Notice to Proceed (NTP) to incur increased costs or time impacts. The official NTP for the applicable change will be granted upon signing of the CTI Log. If the RFI is submitted and signed by the Government without cost and time impacts known, the Government shall return the RFI with the technical direction and request the proposal and TIA by an established suspense date. In either instance, the CTI Log will note the agreed upon price for the change (if any), time extension (if any), and will establish the NTP for the technical direction captured in the RFI.

4. After arriving at a bilateral agreement on price and time impacts associated with the change, the ACO and the contractor’s representative will enter the RFI number and the agreed upon "reasonable price" on the contract CTI Log. At this time, the ACO will electronically sign the applicable log entries, authorizing the contractor to proceed with the scope described by the RFI and at the reasonable price agreed upon. The contractor's authorized representative must also acknowledge the cost and time impact by signing the CTI Log item, prior to proceeding with the work. The official NTP will occur when both the Government and Contractor have both signed the CTI Log.

5. When the aggregate absolute value of changes approaches the appointed ACO's warrant threshold, the individual CTI Log entries (and associated RFls) shall be captured in a single modification document (SF 30). The "SCOPE" paragraph of the modification will contain a summary list of the incorporated CTI Log items. These aggregate modifications will be processed at least once every month, at a different interval as mutually agreed upon, or when expedited processes are needed to pay for critical features of work such that subcontractors have the ability to bill for work completed in the field. The ACO will sign the SF 30 and provide to the contractor for its signature and return. After the SF30 is executed, the Contractor can bill for the earnings included in the associated CTI Log items listed on the SF30.

6. The CTI Log process may be utilized during the performance of this contract unless termination or suspension of this change management process is desired by either party.

1.39 REAL PROPERTY RECORD

Refer to UFC 1-300-08 for instruction on completing the DD FORM 1354. Contact the Contracting Officer for any project specific information necessary to complete the DD FORM 1354. Complete and store the DD Form 1354 in RMS.

1.39.1 Interim DD FORM 1354

Near the completion of Project, but a minimum of 60 days prior to final acceptance of the work, complete and submit an accounting of all installed property with the Interim DD FORM 1354. Include any additional assets, improvements, and alterations from the Draft DD FORM 1354.

1.39.2 Completed DD FORM 1354

Attach the Real Property receiving Component's completed High Performance and Sustainable Building (HPSB) Checklist for each applicable building to the completed DD 1354, in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. For convenience, a blank fillable PDF DD FORM 1354 may be obtained at the following link: www.esd.whs.mil/Portals/54/Documents/DD/forms/dd/dd1354.pdf

Submit the completed List of Installed Building Equipment items for DD FORM 1354. Attach this list to the updated DD FORM 1354.

PART 2 NOT USED

PART 3 EXECUTION

3.1 APPENDIX A- CONTRACT DOCUMENT DISTRIBUTION LIST

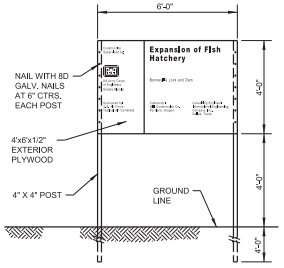
Appendix A - Contract Document Distribution List

Addressee Address	No. of Sets CD/DVD	Full-size	Half Size	Specs
USACE, Omaha ATTN: CENWO-PMM (A. Spies) 1616 Capitol Ave. Omaha, NE 68102-4901	1	0	0	0
Buckley Resident Office (C Magstadt) 19070 E. Sunlight Way, T1012 USPS Stop 53 Buckley SFB, CO 80011-9574	2	1	2	0

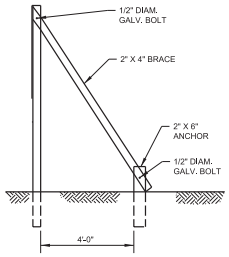
-- End of Section --

MILCON PROJECT SIGN DETAILS

NOTES:
1. THE LARGE 4' X 4' SECTION OF THE PANEL ON THE RIGHT IS TO BE WHITE WITH BLACK LEGEND. THE 2' X 4' SECTION OF THE SIGN ON THE LEFT WITH THE FULL CORPS SIGNATURE (REVERSE VERSION) SHALL BE SCREEN-PRINTED COMMUNICATION WHITE ON THE RED BACKGROUND.
2. PROJECT TITLE LETTERS SHALL BE 3" HELVETICA BOLD. PROJECT LOCATION LETTERS SHALL BE 1.5" HELVETICA REGULAR. ALL OTHER LETTERS SHALL BE 1.25" HELVETICA REGULAR.
3. DECALCOMANIA FOR CORPS OF ENGINEERS SIGNATURE WILL BE FURNISHED BY THE CONTRACTING OFFICER FOR INSTALLATION BY THE CONTRACTOR.



FRONT VIEW



END VIEW

SIGN FRAME DETAILS

NO SCALE

NOTES:
1. POSTS SHALL BE S4S.
2. PLYWOOD SHALL BE EXTERIOR TYPE, A-C GRADE.
3. BEFORE PAINTING, SURFACE SHALL BE CLEAN, DRY, FREE OF GREASE AND SANDED.
4. PAINT WITH ONE EXTERIOR OIL PRIME COAT AND EXTERIOR TYPE ALKYD, CONFORMING TO MASTER PAINTERS INSTITUTE MPI-9, MPI GLOSS LEVEL 6.

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT

MARK	DESCRIPTION	DATE	APPR

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
OMAHA DISTRICT

DESIGNED BY: X
DWN BY: X
CKD BY: X
SUBMITTED BY: X
DATE:
SOLICITATION NO.:
CONTRACT NO.:
FILE NAME: auto_user | auto_design
FILE SIZE: 33.1X22
PLOT DATE: auto_system
PLOT SCALE: auto_scale

STANDARD DETAIL

PROJECT SIGN DETAILS
3/8" = 1'-0"

SHEET IDENTIFICATION NUMBER
C-8.2B

auto_username auto_design

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BASE CIVIL ENGINEERING WORK CLEARANCE REQUEST

(See Instructions on Reverse)

DATE PREPARED

1. Clearance is requested to proceed with work at _____

on Work Order No. _____ , Contract No. _____ , involving excavation or utility disturbance per attached sketch. This area ☐ has ☐ has not been staked or clearly marked.

2. TYPE OF FACILITY/WORK INVOLVED

☐ A. PAVEMENTS	☐ D. FIRE DETECTION & PROTECTION SYSTEMS			☐ G. AIRCRAFT OR VEHICULAR TRAFFIC FLOW
☐ B. DRAINAGE SYSTEMS	☐ E. UTILITY	☐ OVERHEAD	☐ UNDERGROUND	☐ H. SECURITY
☐ C. RAILROAD TRACKS	☐ F. COMM	☐ OVERHEAD	☐ UNDERGROUND	☐ I. OTHER

3. DATE CLEARANCE REQUIRED	4. DATE OF CLEARANCE	
5. SIGNATURE OF REQUESTING OFFICIAL	6. TELEPHONE NO.	7. ORGANIZATION

	ORGANIZATION	REMARKS *(Use Reverse for additional comments)*	REVIEWER'S NAME AND INITIALS
8. BASE CIVIL ENGINEERING	A. ELECTRICAL DISTRIBUTION		
	B. STEAM DISTRIBUTION		
	C. WATER DISTRIBUTION		
	D. POL DISTRIBUTION		
	E. SEWER DISTRIBUTION		
	F. ENVIRONMENTAL		
	G. PAVEMENTS/ GROUNDS		
	H. FIRE PROTECTION		
	I. ZONE _____		
	J. OTHER *(Specify)*		
9. SECURITY POLICE			
10. SAFETY			
11. COMMUNICATIONS			
12. BASE OPERATIONS			
13. CABLE TV			
14. COMMERCIAL UTILITY COMPANY ☐ TELEPHONE ☐ GAS ☐ ELECTRIC			

15. OTHER *(Specify)* _____

16. REQUESTED CLEARANCE ☐ APPROVED ☐ DISAPPROVED

17. TYPED NAME AND SIGNATURE OF APPROVING OFFICER *(Chief of Operations Flight or Chief of Engineering Flight)*	17a. DATE SIGNED

AF IMT 103, 19940801, V3 PREVIOUS EDITIONS ARE OBSOLETE.

INSTRUCTIONS

The BCE work clearance request is used for any work (contract or in-house) that may disrupt aircraft or vehicular traffic flow, base utility services, protection provided by fire and intrusion alarm system, or routine activities of the installation. This form is used to coordinate the required work with key base activities and keep customer inconvenience to a minimum. It is also used to identify potentially hazardous work conditions in an attempt to prevent accidents. The work clearance request is processed just prior to the start of work. If delays are encountered and the conditions at the job site change (or may have changed) this work clearance request must be reprocessed.

18. REMARKS. *(This section must describe specific precautionary measure to be taken before and during work accomplishment. Specific comments concerning the approved method of excavation, hand or powered equipment, should be included.)*

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08/23, CHG 1: 08/24

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PROJECT SCHEDULE
08/23, CHG 1: 08/24

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AACE INTERNATIONAL (AACE)

AACE 29R-03	(2011) Forensic Schedule Analysis
AACE 52R-06	(2006) Time Impact Analysis - As Applied in Construction
AACE 84R-13	(2015) Planning and Accounting for Adverse Weather

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 67-17	(2017) Schedule Delay Analysis

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 1-1-11	(2017) Administration -- Project Schedules

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Project Scheduler Qualifications; G, RO

Preliminary Project Schedule; G, RO

Initial Project Schedule; G, RO

Periodic Schedule Update; G, RO

1.3 PROJECT SCHEDULER QUALIFICATIONS

Designate an authorized representative to be responsible for the preparation of the schedule and all required updating and production of reports. The Designated Project Scheduler must have prepared and maintained at least three previous construction schedules for projects of

similar size and complexity to this contract, using Primavera P6.. Representative must have a comprehensive knowledge of CPM scheduling principles and application.

PART 2 PRODUCTS

2.1 SOFTWARE

The scheduling software utilized to produce and update the schedules required herein must be capable of meeting all requirements of this specification.

2.1.1 Government Default Software

The Government uses Primavera P6. Ensure exported schedule files are compatible with the version of P6 used by the Government.

2.1.2 Contractor Software

Scheduling software used by the contractor must be commercially available from the software vendor for purchase with vendor software support agreements available. The software routine used to create the required sdef file must be created and supported by the software manufacturer.

2.1.2.1 Primavera

If Primavera P6 is selected for use, provide the "xer" export file in a version of P6 importable by the Government system. Verify at the SEKO meeting which version of P6 is in use by the Government. Export the schedule in a version of P6 no newer than that used by the Government.

2.1.2.2 Other Than Primavera

If the Contractor chooses software other than Primavera P6, that is compliant with this specification, provide for the Government's use two licenses, two computers, and training for two Government employees in the use of the software. These computers will be stand-alone and not connected to Government network. Computers and licenses will be returned at project completion.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Prepare for approval a Project Schedule, as specified herein, pursuant to FAR Clause 52.236-15 Schedules for Construction Contracts. Show in the schedule the proposed sequence to perform the work and dates contemplated for starting and completing all schedule activities. The scheduling of the entire project is required. The scheduling of construction is the responsibility of the Contractor. Contractor management personnel must actively participate in its development. Subcontractors, and suppliers working on the project must also contribute in developing and maintaining an accurate Project Schedule. Provide a schedule that is a forward planning as well as a project monitoring tool. Use the Critical Path Method (CPM) of network calculation to generate all Project Schedules. Prepare each Project Schedule using the Precedence Diagram Method (PDM).

3.1.1 Scheduling Expectations Kickoff Meeting(SEKO)

In conjunction with the post award conference or pre construction conference the Government and the Contractor will hold a separate and distinct Scheduling Expectations Kickoff Meeting(SEKO). The intent of this meeting is for the Government to review with the contractor the requirements of the scheduling specification, communicate the Government’s expectations regarding schedule development and management, and answer any questions the Contractor may have regarding the schedule requirements.

3.2 BASIS FOR PAYMENT AND COST LOADING

The schedule is the basis for determining contract earnings during each update period and therefore the amount of each progress payment. The aggregate value of all activities coded to a contract CLIN must equal the value of the CLIN. Match the progress payment "Pay Period Thru" date in RMS to the schedule data date.

3.2.1 Activity Cost Loading

Activity cost loading must be reasonable and without front-end loading. Activities with a negative cost loading is not allowed. Provide additional documentation to demonstrate reasonableness if requested by the Contracting Officer.

3.2.2 Cost Loading of Submittals

No costs are to be assigned to activities for the preparation, review, or approval of submittals, except as described under paragraph COST LOADING OF CLOSEOUT ACTIVITIES, paragraph AS-BUILT DRAWINGS, and paragraph O&M MANUALS.

3.2.3 Withholdings / Payment Rejection

Failure to meet the requirements of this specification may result in the disapproval of the preliminary, initial, or periodic schedule updates and subsequent rejection of payment requests until compliance is met.

In the event that the Contracting Officer directs schedule revisions and those revisions have not been included in subsequent Project Schedule revisions or updates, the Contracting Officer may withhold 10 percent of pay request amount from each payment period until such revisions to the project schedule have been made.

3.3 PROJECT SCHEDULE DETAILED REQUIREMENTS

3.3.1 Level of Detail Required

Develop the Project Schedule to the appropriate level of detail to address major milestones and to allow for satisfactory project planning and execution. Failure to develop the Project Schedule to an appropriate level of detail will result in its disapproval. The Contracting Officer will consider, but is not limited to, the following characteristics and requirements to determine appropriate level of detail:

3.3.2 Activity Durations

Reasonable activity durations are those that allow the progress of ongoing activities to be accurately determined between update periods.

Non-procurement activities Original Durations (OD) are not to exceed 20 workdays or 30 calendar days.

3.3.3 Procurement Activities

Include in the schedule activities associated with the critical submittals and their approvals, procurement, fabrication, and delivery of long lead materials, equipment, fabricated assemblies, and supplies. Long lead procurement activities are those with an anticipated procurement sequence of over 90 calendar days.

3.3.4 Mandatory Activities

Include the following activities in the initial project schedule and all updates.

a. Submission, review and acceptance of SD-01 Preconstruction Submittals (individual activity for each).

b. Submission, review and acceptance of features requiring design completion

c. Submission of mechanical/electrical/information systems layout drawings.

d. Submission and approval of O & M manuals.

e. Submission and approval of as-built drawings.

f. Submission and approval of DD1354 data and installed equipment lists.

g. Submission and approval of testing and air balance (TAB).

h. Submission of TAB specialist design review report.

i. Submission and approval of fire protection specialist.

j. Submission and approval of Building Commissioning Plan, Controls testing plan, test data, and reports: Develop the schedule logic associated with testing and commissioning of mechanical systems to a level of detail consistent with the contract commissioning requirements. All tasks associated with building testing and commissioning will be completed prior to submission of building commissioning report and subsequent contract completion.

   These activities may include but are not limited to: air and water balancing, building commissioning -functional performance testing, controls testing, and performance verification testing. Include other systems testing, if required. Include additional commissioning requirements noted elsewhere in the Contract as required in the schedule and discuss during the SEKO meeting, noted in paragraph SCHEDULING EXPECTATIONS KICKOFF MEETING (SEKO).

k. Contractor's pre-final inspection.

m. Correction of punch list from Contractor's pre-final inspection.

n. Government's pre-final inspection.

o. Correction of punch list from Government's pre-final inspection.

p. Final inspection.

3.3.5 Government Activities

Show in schedule, Government and other agency activities that could impact progress. These activities include, but are not limited to approvals, environmental permit approvals by State regulators, inspections, utility tie-in, Government Furnished Equipment (GFE) and Notice to Proceed (NTP) for phasing requirements.

3.3.6 Standard Activity Coding Dictionary

Use the activity coding structure defined in the Standard Data Exchange Format (SDEF) in ER 1-1-11. This exact structure is mandatory. Develop and assign all Activity Codes to activities as detailed herein.

The SDEF format is as follows:

Field	Activity Code	Length	Description
1	WRKP	3	Workers per day
2	RESP	4	Responsible party
3	AREA	4	Area of work
4	MODF	6	Modification Number
5	BIDI	6	Bid Item (CLIN)
6	PHAS	2	Phase of work
7	CATW	1	Category of work
8	FOW	20	Feature of work*

*Some systems require that FEATURE OF WORK values be placed in several activity code fields. The notation shown is for Primavera P6. Refer to the specific software guidelines with respect to the FEATURE OF WORK field requirements.

3.3.6.1 Workers Per Day (WRKP)

Assign Workers per Day for all field construction or direct work activities, if directed by the Contracting Officer. Workers per day is based on the average number of workers expected each day to perform a task for the duration of that activity.

3.3.6.2 Responsible Party Coding (RESP)

Assign responsibility code for all activities to the Prime Contractor, Subcontractor(s) or Government agency(ies) responsible for performing the

activity.

a. Activities coded with a Government Responsibility code include, but are not limited to: Government approvals, Government design reviews, environmental permit approvals by State regulators, Government Furnished Property/Equipment (GFP) and Notice to Proceed (NTP) for phasing requirements.

b. Activities cannot have more than one Responsibility Code. Examples of acceptable activity code values are: DOR (for the designer of record); ELEC (for the electrical subcontractor); MECH (for the mechanical subcontractor); and GOVT (for USACE).

3.3.6.3 Area of Work Coding (AREA)

Assign Work Area code to activities based upon the work area in which the activity occurs. Define work areas based on resource constraints or space constraints that would preclude a resource, such as a particular trade or craft work crew from working in more than one work area at a time due to restraints on resources or space. Examples of Work Area Coding include different areas within a floor of a building, different floors within a building, and different buildings within a complex of buildings. Activities cannot have more than one Work Area Code.

3.3.6.4 Modification Number (MODF)

Assign a Modification Number Code to any activity or sequence of activities added to the schedule as a result of a Contract Modification, when approved by Contracting Officer. Key all Code values to the Government's modification numbering system. An activity can have only one Modification Number Code.

3.3.6.5 Bid Item Coding (BIDI)

Assign a Bid Item Code to all activities using the Contract Line Item Number (CLIN) to which the activity belongs, even when an activity is not cost loaded. An activity can have only one BIDI Code.

3.3.6.6 Phase of Work Coding (PHAS)

Assign Phase of Work Code to all activities. Examples of phase of work are procurement phase and construction phase. Each activity can have only one Phase of Work code.

a. Code proposed fast track design and construction phases proposed to allow filtering and organizing the schedule by fast track design and construction packages.

b. If the contract specifies phasing with separately defined performance periods, identify a Phase Code to allow filtering and organizing the schedule accordingly.

3.3.6.7 Category of Work Coding (CATW)

Assign a Category of Work Code to all activities. Category of Work Codes include, but are not limited to construction submittal, procurement, fabrication, weather sensitive installation, non-weather sensitive installation, start-up, and testing activities. Each activity can have no more than one Category of Work Code.

3.3.6.8 Feature of Work Coding (FOW)

Assign a Feature of Work Code to appropriate activities based on the Definable Feature of Work to which the activity belongs based on the approved QC plan.

Definable Feature of Work is defined in Section 01 45 00 QUALITY CONTROL. An activity can have only one Feature of Work Code.

3.3.7 Contract Milestones and Constraints

Milestone activities are to be used for significant project events including, but not limited to, project phasing, project start and end activities, or interim completion dates. The use of artificial float constraints such as "zero free float" or "zero total float" are prohibited.

Mandatory constraints that ignore or affect network logic are prohibited. No constrained dates are allowed in the schedule other than those specified herein. Submit additional constraints to the Contracting Officer for approval on a case by case basis.

3.3.7.1 Project Start Date Milestone and Constraint

The first activity in the project schedule must be a start milestone titled "NTP Acknowledged," which must have a "Start On" constraint date equal to the date that the NTP is acknowledged.

3.3.7.2 End Project Finish Milestone and Constraint

The last activity in the schedule must be a finish milestone titled "End Project."

Constrain the project schedule to the Contract Completion Date in such a way that if the schedule calculates an early finish, then the float calculation for "End Project" milestone reflects positive float on the longest path. If the project schedule calculates a late finish, then the "End Project" milestone float calculation reflects negative float on the longest path.

3.3.7.3 Interim Completion Dates and Constraints

Constrain contractually specified interim completion dates to show negative float when the calculated late finish date of the last activity in that phase is later than the specified interim completion date.

3.3.7.3.1 Start Phase

Use a start milestone as the first activity for a project phase. Call the start milestone "Start Phase X" where "X" refers to the phase of work.

3.3.7.3.2 End Phase

Use a finish milestone as the last activity for a project phase. Call the finish milestone "End Phase X" where "X" refers to the phase of work.

3.3.8 Adverse Weather

Ensure anticipated adverse weather is accounted for in the Project Schedule. AACE 84R-13 provides methodologies for techniques in planning for adverse weather. The preferred methodology is the use of a weather calendar. If a method other than a weather calendar is proposed, discuss the reason during the SEKO meeting.

3.3.9 Calendars

Schedule activities on a Calendar to which the activity logically belongs. Develop calendars to accommodate any contract defined work period such as a 7-day calendar for Government Acceptance activities, concrete cure times, etc. Develop the default Calendar to match the physical work plan with non-work periods identified including weekends and holidays. Develop Seasonal Calendar(s) and assign to seasonally affected activities as applicable.

If a weather calendar is used its implementation and execution is to be in accordance with AACE 84R-13

3.3.10 Open Ended Logic

Only two open ended activities are allowed: the first activity "NTP Acknowledged" is to have no predecessor logic, and the last activity -"End Project" is to have no successor logic. Except as noted above, each activity must have at least a start-to-start or finish-to-start relationship with its predecessor and a finish-to-finish or finish-to-start relationship with its successor.

Predecessor open ended logic may be allowed in a time impact analyses upon the Contracting Officer's approval.

3.3.11 Default Progress Data Disallowed

Actual Start and Finish dates must not automatically update with default mechanisms included in the scheduling software. Updating of the percent complete and the remaining duration of any activity must be independent functions. Disable program features that calculate one of these parameters from the other. Activity Actual Start (AS) and Actual Finish (AF) dates assigned during the updating process must match those dates provided in the Contractor Quality Control Reports. Failure to document the AS and AF dates in the Daily Quality Control report will result in disapproval of the Contractor's schedule.

3.3.12 Out-of-Sequence Progress

Activities that have progressed before all preceding logic has been satisfied (Out-of-Sequence Progress) will be allowed only on a case-by-case basis subject to approval by the Contracting Officer. Propose logic corrections to eliminate out of sequence progress or justify not changing the sequencing for approval prior to submitting an updated project schedule. Address out of sequence progress or logic changes in the Narrative Report and in the periodic schedule update meetings.

3.3.13 Added and Deleted Activities

Do not delete activities from the project schedule or add new activities to the schedule without approval from the Contracting Officer. Activity

ID and description changes are considered new activities and cannot be changed without Contracting Officer approval.

3.3.14 Original Durations

Activity Original Durations (OD) must be reasonable to perform the work item. OD changes are prohibited unless justification is provided and approved by the Contracting Officer.

3.3.15 Leads, Lags, and Start to Finish Relationships

Lags must be reasonable as determined by the Government and not used in place of realistic original durations, must not be in place to artificially absorb or create float, or to replace proper schedule logic.

a. Leads (negative lags) are prohibited.

b. Start to Finish (SF) relationships are prohibited.

3.3.16 Retained Logic

Schedule calculations must retain the logic between predecessors and successors ("retained logic" mode) even when the successor activity(s) starts and the predecessor activity(s) has not finished (out-of-sequence progress). Software features that in effect sever the tie between predecessor and successor activities when the successor has started and the predecessor logic is not satisfied ("progress override") are not be allowed.

3.3.17 Percent Complete

Update the percent complete for each activity started, based on the realistic assessment of earned value. Activities which are complete but for remaining minor punch list work and which do not restrain the initiation of successor activities may be declared 100 percent complete to allow for proper schedule management. Budgeted cost of activity is to be reduced by the amount needed to correct deficiency. The activity referenced in paragraph COST LOADING of CLOSEOUT ACTIVITIES must have its budgeted cost increased by this amount.

3.3.18 Remaining Duration

Update the remaining duration for each activity based on the number of estimated workdays it will take to complete the activity. Remaining duration may not mathematically correlate with percentage found under paragraph entitled Percent Complete. The remaining duration for unstarted activities are not to be less than its orginal duration.

3.3.19 Cost Loading of Closeout Activities

Cost load the "Correction of punch list from Government pre-final inspection" activity(ies) not less than 1 percent of the present contract value. Activity(ies) may be declared 100 percent complete upon the Government's verification of completion and correction of all punch list work identified during Government pre-final inspection(s).

3.3.19.1 As-Built Drawings

If there is no separate contract line item (CLIN) for as-built drawings,

cost load the "Submission and approval of as-built drawings" activity not less than $35,000 or 1 percent of the present contract value, which ever is greater, up to $200,000. Activity will be declared 100 percent complete upon the Government's approval.

3.3.19.2 O & M Manuals

Cost load the "Submission and approval of O & M manuals" activity not less than $20,000. Activity will be declared 100 percent complete upon the Government's approval of all O & M manuals.

3.3.20 Early Completion Schedule and the Right to Finish Early

An Early Completion Schedule is an Initial Project Schedule (IPS) that indicates all scope of the required contract work will be completed before the contractually required completion date.

a. No IPS indicating an Early Completion will be accepted without being fully resource-loaded (including crew sizes and manhours) and the Government agreeing that the schedule is reasonable and achievable.

b. The Government is under no obligation to accelerate work items it is responsible for to ensure that the early completion is met nor is it responsible to modify incremental funding (if applicable) for the project to meet the contractor's accelerated work.

3.4 PROJECT SCHEDULE SUBMISSIONS

Provide the submissions as described below. The data reports and network diagrams required for each submission are contained in paragraph SUBMISSION REQUIREMENTS. If the Contractor fails or refuses to furnish the information and schedule updates as set forth herein, the Contractor will be deemed not to have provided an estimate upon which a progress payment can be made.

Review comments made by the Government on the schedule(s) do not relieve the Contractor from compliance with requirements of the Contract Documents.

3.4.1 Preliminary Project Schedule Submission

Within 15 calendar days after the NTP is acknowledged, submit the Preliminary Project Schedule defining the planned operations detailed for the first 90 calendar days for approval. The approved Preliminary Project Schedule will be used for payment purposes not to exceed 90 calendar days after NTP. Completely cost load the Preliminary Project Schedule to balance the contract award CLINS shown on the Price Schedule. The Preliminary Project Schedule may be summary in nature for the remaining performance period. It must be early start and late finish constrained and logically tied as specified. The Preliminary Project Schedule forms the basis for the Initial Project Schedule specified herein and must include all of the required plan and program preparations, submissions and approvals identified in the contract (for example, Quality Control Plan, Safety Plan, and Environmental Protection Plan) as well as design activities, planned submissions of all early design packages, permitting activities, design review conference activities, and other non-construction activities intended to occur within the first 90 calendar days. Government acceptance of the associated design package(s) and all other specified Program and Plan approvals must occur prior to any planned construction activities. Code activities that are summary in nature,

after the first 90 calendar days, with the following activity codes: Bid Item (CLIN) code (BIDI), Responsibility Code (RESP), and Feature of Work code (FOW)..

3.4.2 Initial Project Schedule Submission

Submit the Initial Project Schedule for approval within 42 calendar days after notice to proceed is issued. The schedule must demonstrate a reasonable and realistic sequence of activities which represent all work through the entire contract performance period. No payment will be made for work items not fully detailed in the Project Schedule.

3.4.3 Periodic Schedule Updates

Update the Project Schedule on a regular basis, monthly at a minimum. Provide a draft Periodic Schedule Update for review at the schedule update meetings as prescribed in the paragraph PERIODIC SCHEDULE UPDATE MEETINGS. These updates will enable the Government to assess Contractor's progress.

a. Update information including Actual Start Dates (AS), Actual Finish Dates (AF), Remaining Durations (RD), and Percent Complete. Updated information is subject to the approval of the Government at the meeting.

b. AS and AF dates must match the date(s) reported on the Contractor's Quality Control Report for an activity start or finish.

3.5 SUBMISSION REQUIREMENTS

Submit the following items for the Preliminary Schedule, Initial Schedule, and every Periodic Schedule Update throughout the life of the project:

3.5.1 Electronic Scheduling Data

Provide electronic scheduling data containing the current project schedule and all previously submitted schedules in the format of the scheduling software (e.g. .xer). Also include the Narrative Report and all required Schedule Reports. The electronic file is to identify the type of schedule (Preliminary, Initial, Update), full contract number, Data Date and schedule file name. Each schedule must have a unique file name and use project specific settings. The file naming convention is to be determined at SEKO meeting.

3.5.2 Narrative Report

Provide a Narrative Report with each schedule submission. The Schedule Narrative Report is a "stand alone" report in PDF or Word format. Title the report "Schedule Narrative Report". Show the Report date, schedule name, and contract number on the first page. Indicate who is responsible for the schedule update and narrative report. Provide a brief description of the Project Scope. The Narrative Report is expected to communicate to the Government the thorough analysis of the schedule output and the plans to compensate for problems, either current or potential, which are revealed through that analysis. Include the following information at a minimum in the Narrative Report:

a. Identify and discuss the work scheduled to start in the next update period.

b. Describe activities along the critical path in addition to activities on the next float path after the critical path.

c. Describe current and anticipated problem areas, delaying factors and their impact, and an explanation of corrective actions taken or required to be taken. Identify the party responsible for delay, if applicable.

d. Identify and explain why activities, based on their calculated late dates, should have either started or finished during the update period but did not.

e. Identify and discuss all schedule changes by activity ID and activity name including what specifically was changed and why the change was needed. Include at a minimum new and deleted activities, logic changes, duration changes, calendar changes, lag changes, resource changes, and actual start and finish date changes.

f. Identify and discuss out-of-sequence work.

g. If the longest path changes from a monthly update to the next, provide an explanation of the factors driving the change.

h. Respond to USACE Schedule Review Comments from the previous update(s).

3.5.3 Schedule Reports

The format, filtering, organizing, and sorting for each schedule report will be as directed by the Contracting Officer. Typically, reports contain Activity Numbers, Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float, Actual Start Date, Actual Finish Date, and Percent Complete. Provide the reports electronically in .pdf format. The following lists typical reports that will be requested:

3.5.3.1 Activity Report

List of all activities sorted according to activity number.

3.5.3.2 Logic Report

List of detailed predecessor and successor activities for every activity in ascending order by activity number.

3.5.3.3 Total Float Report

A list of all incomplete activities sorted in ascending order of total float. List activities which have the same amount of total float in ascending order of Early Start Dates. Do not show completed activities on this report.

3.5.3.4 Earnings Report by CLIN

A compilation of the Total Earnings on the project from the NTP to the data date, which reflects the earnings of activities based on the agreements made in the schedule update meeting defined herein. Provided a complete schedule update has been furnished, this report serves as the basis of determining progress payments. Group activities by CLIN number

and sort by activity number. Provide a total CLIN percent earned value, CLIN percent complete, and project percent complete. The printed report must contain the following for each activity: the Activity Number, Activity Description, Original Budgeted Amount, Earnings to Date, Earnings this period, Total Quantity, Quantity to Date, and Percent Complete (based on cost).

3.5.3.5 Scheduling and Leveling Report

Provide a Scheduling/Leveling Report generated from the current project schedule being submitted.

3.5.4 Network Diagram

The Network Diagram is required for the Preliminary, Initial and Periodic Updates. Depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Contracting Officer will use, but is not limited to, the following conditions to review compliance with this paragraph:

3.5.4.1 Continuous Flow

Show a continuous flow from left to right with no arrows from right to left. Show the activity number, description, duration, and estimated earned value on the diagram.

3.5.4.2 Project Milestone Dates

Show dates on the diagram for start of project, any contract required interim completion dates, and contract completion dates.

3.5.4.3 Critical Path

Show all activities on the critical path. The critical path is defined as the longest path.

3.5.4.4 Grouping and Sorting

Group and sort activities as directed to assist in the understanding of the activity sequence. Typically, this flow will group activities by major elements of work, category of work, work area and/or responsibility.

3.5.4.5 Cash Flow / Schedule Variance Control (SVC) Diagram

With each schedule submission, provide a SVC diagram showing 1) Cash Flow S-Curves indicating planned project cost based on projected early and late activity finish dates, and 2) Earned Value to-date.

3.6 PERIODIC SCHEDULE UPDATE

3.6.1 Periodic Schedule Update Meetings

Conduct periodic schedule update meetings for the purpose of reviewing the proposed Periodic Schedule Update, Narrative Report, Schedule Reports, and progress payment. Conduct meetings at least monthly within five days of the proposed schedule data date. Provide a computer with the scheduling software loaded and a projector which allows all meeting participants to view the proposed schedule during the meeting. The Contractor's authorized scheduler must organize, group, sort, filter, perform schedule

revisions as needed and review functions as requested by the Contractor and/or Government. The Contractor scheduler must attend in person unless virtual attendance is approved by Contracting Officer. The meeting is a working interactive exchange which allows the Government and Contractor the opportunity to review the updated schedule on a real time and interactive basis. The meeting will last no longer than 8 hours. Submit schedule file and narrative to the Government a minimum of two workdays in advance of the meeting. The Contractor's Project Manager must attend the meeting with the authorized representative of the Contracting Officer. Superintendents, foremen and major subcontractors must attend the meeting as required to discuss the project schedule and work. Following the schedule update meeting, make corrections to the schedule and resubmit, following the required schedule naming convention. Include only those changes approved by the Government in the schedule review meeting. Only approved schedules may be used to generate invoices for payment.

3.6.2 Update Submission Following Progress Meeting

Submit the complete Periodic Schedule Update of the Project Schedule containing all approved progress, revisions, and adjustments, pursuant to paragraph SUBMISSION REQUIREMENTS not later than 4 workdays after the periodic schedule update meeting.

3.7 WEEKLY PROGRESS MEETINGS

Conduct a weekly meeting with the Government (or as otherwise mutually agreed to) between the meetings described in paragraph entitled PERIODIC SCHEDULE UPDATE MEETINGS for the purpose of jointly reviewing the actual progress of the project as compared to the as planned progress and to review planned activities for the upcoming two weeks. Use the current approved schedule update for the purposes of this meeting and for the production and review of reports. At the weekly progress meeting, address the status of RFIs, RFPs and Submittals.

3.8 REQUESTS FOR TIME EXTENSIONS

ASCE 67-17 provides delay analysis guidelines. If there is a conflict between the contract and guidance provided in ASCE 67-17, the contract will govern. Provide justification of delay to the Contracting Officer in accordance with the contract provisions and clauses for approval, within 10 days of a delay occuring. Also prepare a time impact analysis for each Government request for proposal (RFP).

3.8.1 Justification of Delay

Provide a description of the event(s) that caused the delay and/or impact to the work. As part of the description, identify all schedule activities impacted. Show that the event that caused the delay/impact was the responsibility of the Government. Provide a time impact analysis that demonstrates the effects of the delay or impact on the project completion date, or interim completion date(s). Evaluate multiple impacts chronologically; each with its own justification of delay. With multiple impacts consider any concurrency of delay. A time extension and the schedule fragnet becomes part of the project schedule and all future schedule updates upon approval by the Contracting Officer.

3.8.2 Changes That Do Not Cause Delay

If it is determined that a change does not constitute a schedule time

extension, a fragnet as described in paragraph FRAGMENTARY NETWORK, is to be created and inserted into the Project schedule.

3.8.3 Time Impact Analysis (Prospective Analysis)

Submit requests for time extensions based on a prospective analysis if the work involved or the impact identified has not already occurred. Where the impact is ongoing a prospective analysis may be considered. However, the Government reserves the right to require a retrospective analysis be prepared after the impact has ended.

Prepare a time impact analysis for approval by the Contracting Officer based on industry recommended practice AACE 52R-06. Utilize a copy of the last approved schedule prior to the first day of the impact or delay for the time impact analysis. If Contracting Officer determines the time frame between the last approved schedule and the first day of impact is too great, prepare an interim updated schedule to perform the time impact analysis. Unless approved by the Contracting Officer, no other changes may be incorporated into the schedule being used to justify the time impact.

3.8.4 Forensic Schedule Analysis (Retrospective Analysis)

Submit requests for time extensions based on a retrospective analysis if the work involved or the impact identified has already occurred. The analysis must account for the actual performance of both the impacted work and all other contract work in the schedule.

If a methodology is chosen from AACE 29R-03, the method must adhere to the principles identified in ASCE 67-17. If there is a conflict with the methodology chosen from AACE 29R-03 and ASCE 67-17, ASCE 67-17 will govern. Choice of methodology should be discussed prior to submission to Government.

3.8.5 Fragmentary Network (Fragnet)

Prepare a proposed fragnet for time impact analysis consisting of a sequence of new activities that are proposed to be added to the project schedule to demonstrate the influence of the delay or impact to the project's contractual dates. Clearly show how the proposed fragnet is to be tied into the project schedule including all predecessors and successors to the fragnet activities. The proposed fragnet must be approved by the Contracting Officer prior to incorporation into the project schedule.

3.8.6 Time Extension

The Contracting Officer must approve the Justification of Delay including the time impact analysis before a time extension will be granted. No time extension will be granted unless the delay consumes all available Project Float and extends the projected finish date ("End Project" milestone) beyond the Contract Completion Date. The time extension will be in calendar days.

Actual delays that are found to be caused by the Contractor's own actions, which result in a calculated schedule delay, are not a cause for an extension to the performance period, completion date, or any interim milestone date.

3.8.7 Impact to Early Completion Schedule

No extended overhead will be paid for delay prior to the original Contract Completion Date for an Early Completion IPS unless the Contractor actually performed work in accordance with that Early Completion Schedule. The Contractor must show that an early completion was achievable had it not been for the impact.

3.9 FAILURE TO ACHIEVE PROGRESS

Should the progress fall behind the approved project schedule for reasons other than those that are excusable within the terms of the contract, the Contracting Officer may require provision of a written recovery plan for approval. The plan must detail how progress will be made-up to include which activities will be accelerated by adding additional crews, longer work hours, extra workdays, etc.

3.9.1 Artificially Improving Progress

Artificially improving progress by means such as, but not limited to, revising the schedule logic, modifying, or adding constraints, shortening activity durations, or changing calendars in the project schedule is prohibited. Indicate assumptions made and the basis for any logic, constraint, duration, and calendar changes used in the creation of the recovery plan. Any additional resources, manpower, or daily and weekly work hour changes proposed in the recovery plan must be evident at the work site and documented in the daily report along with the Schedule Narrative Report.

3.9.2 Failure to Perform

Failure to perform work and maintain progress in accordance with the supplemental recovery plan may result in an interim and final unsatisfactory performance rating and may result in corrective action directed by the Contracting Officer pursuant to FAR 52.236-15 Schedules for Construction Contracts, FAR 52.249-10 Default (Fixed-Price Construction), and other contract provisions.

3.9.3 Recovery Schedule

Should the Contracting Officer find it necessary, submit a recovery schedule pursuant to FAR 52.236-15 Schedules for Construction Contracts.

3.10 OWNERSHIP OF FLOAT

Except for the provision given in the paragraph IMPACT TO EARLY COMPLETION SCHEDULE, float available in the schedule, at any time, belongs to the Project and is available for Contractor and Government use. This includes activity and project float. Activity float is the number of workdays that an activity can be delayed without causing a delay to the "End Project" finish milestone. Project float (if applicable) is the number of work days between the projected early finish and the "End Project" finish.

3.11 TRANSFER OF SCHEDULE DATA INTO RESIDENT MANAGEMENT SYSTEM

Ensure schedule data is uploaded to RMS. This data is additional supporting data in a form and detail required by the Contracting Officer pursuant to FAR 52.232-5 Payments under Fixed-Price Construction Contracts. The receipt of a proper payment request pursuant to FAR

52.232-27 Prompt Payment for Construction Contracts is contingent upon the Government receiving both acceptable and approvable hard copies and matching electronic versions of the application for progress payment.

3.12 PRIMAVERA P6 MANDATORY REQUIREMENTS

Ensure Primavera P6 settings provide a schedule capable of fulfilling the requirements of the contract. The following settings are mandatory and required in all schedule submissions to the Government:

a. Activity Codes must be Project Level, not Global or EPS level.

b. Calendars must be Project Level, not Global or Resource level.

c. Activity Duration Types must be set to "Fixed Duration & Units".

d. Percent Complete Types must be set to "Physical".

e. Time Period Admin Preferences must remain the default "8.0 hr/day, 40 hr/week, 172 hr/month, 2000 hr/year". Set Calendar Work Hours/Day to 8.0 Hour days.

f. Set Schedule Option for defining Critical Activities to "Longest Path".

g. Set Schedule Option for defining progressed activities to "Retained Logic".

h. Set up cost loading using a single lump sum non-labor resource. The Price/Unit must be $1/hr, Default Units/Time must be "8h/d", and settings "Auto Compute Actuals" and "Calculate costs from units" un-selected.

i. Activity ID's must not exceed 10 characters.

j. Activity Names must have a verb-noun structure and contain the most defining and detailed description within the first 30 characters.

k. The daily ending hour for all work calendars must be the same.

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SECTION 01 33 00

SUBMITTAL PROCEDURES
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PART 1 GENERAL

1.1 SUMMARY

1.1.1 Submittal Information

The Contractor is responsible for total management of their work including, but not limited to, approval, scheduling, control, certification of all submittals and compliance with all applicable Buy-American and Trade Agreement clauses. The submittal management system provided in these specifications is intended to be a complete system for the Contractor to use to control the quality of materials, equipment and workmanship provided by manufacturers, fabricators, suppliers and subcontractors. Review each submittal for contract compliance. **Compliance with all applicable Buy American and Trade Agreement Clauses is to be included in this review. The Contractor must provide the country of origin on ENG Form 4025 for each item submitted.** The Submittal Register (ENG Form 4288) will be utilized to log and monitor all submittal activities.

The Contracting Officer may request submittals, in addition to those specified, when deemed necessary to adequately describe the work covered in the respective sections. Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.

Units of weights and measures used on all submittals are to be the same as those used in the contract drawings.

1.1.2 Project Type

The Contractor's Quality Control (CQC) System Manager is to check and approve all items before submittal and stamp, sign, and date indicating action taken. Clearly identify proposed deviations from the contract requirements. Include within submittals items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required items.

1.1.3 Submission of Submittals

Schedule and provide submittals requiring Government approval, after notice to proceed (NTP). Provide ample lead time to ensure the submittal's processing by the Government and any lead time needed by the manufacturer upon ordering after approval. Dispose of samples not incorporated into the work in accordance with manufacturer's Safety Data Sheets (SDS) and in compliance with existing laws and regulations.

1.2 DEFINITIONS

1.2.1 Submittal Descriptions (SD)

Submittal requirements are specified in the technical sections. Examples and descriptions of submittals identified by the Submittal Description (SD) numbers and titles follow:

SD-01 Preconstruction Submittals

Submittals that are required prior to or at the start of construction (work) or the next major phase of the construction on a multiphase contract.

Preconstruction Submittals include schedules and a tabular list of locations, features, and other pertinent information regarding products, materials, equipment, or components to be used in the work.

The Government reserves the right to handle pre-construction submittals (listed below) as administrative submittals via a Serial Letter, as directed by the Project, Area or Resident Office. When directed by the Project, Area or Resident Office (as directed), submit administrative submittals for acceptance by the Government. Format for the Serial Letter will be as directed by the Project, Area or Resident Office.

Certificates Of Insurance

Surety Bonds

List Of Proposed Subcontractors

List Of Proposed Products

Baseline Network Analysis Schedule (NAS)

Submittal Register

Schedule Of Prices Or Earned Value Report

Accident Prevention Plan

Work Plan

Quality Control (QC) plan

Permits

Environmental Protection Plan

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards ensuring work can be judged. Includes assemblies or portions of assemblies that are to be incorporated into the project and those that will be removed at conclusion of the work.

SD-05 Design Data

Design calculations, mix designs, analyses or other data pertaining to a part of work.

SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. Unless specified in another section, testing must have been within three years of date of contract award for the project.

Report that includes findings of a test required to be performed on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report that includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

Investigation reports

Daily logs and checklists

Final acceptance test and operational test procedure

SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by

responsible officials of manufacturer of product, system or material attesting that the product, system, or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

Document required of Contractor, or of a manufacturer, supplier, installer or Subcontractor through Contractor. The document purpose is to further promote the orderly progression of a portion of the work by documenting procedures, acceptability of methods, or personnel qualifications.

Confined space entry permits

Text of posted operating instructions

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and (SDS)concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must be signed by an authorized official of a testing laboratory or agency and state the test results; and indicate whether the material, product, or system has passed or failed the test.

Factory test reports.

SD-10 Operation and Maintenance Data

Data provided by the manufacturer, or the system provider, including manufacturer's help and product line documentation, necessary to maintain and install equipment, for operating and maintenance use by facility personnel.

Data required by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

Data incorporated in an operations and maintenance manual or control system.

SD-11 Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

Submittals required for Guiding Principle Validation (GPV) or Third Party Certification (TPC).

Special requirements necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

1.2.2 Approving Authority

Office or designated person authorized to approve the submittal.

1.2.3 Work

As used in this section, on-site and off-site construction required by contract documents, including labor necessary to produce submittals, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction. In exception, excludes work to produce SD-01 submittals.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having any designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with this section. When directed by the Government, the submittal register may be submitted via Section of 01 45 00.15 10 RESIDENTIAL MANAGMENT SYSTEM CONTRACTOR MODE (RMS-CM) in lieu of the copy attached to this section. SpecsIntact is the software system used by Government to generate the Submittal Register that is loaded into RMS-CM.

SD-01 Preconstruction Submittals

Submittal Register; G, RO

1.3.1 Action Codes

1.3.1.1 Contractor Action Codes

DESIGN BID BUILD SUBMITTALS			
Submittal Classifications shown in UFGS Sections	Submittal Classification	Corresponding SpecsIntact Submittal Register Code which is populated in the SI Submittal Register. Software Limitations: (The software shows one character delineation in the SpecsIntact Submittal Register)	RMS – The following Submittal Classifications are populated in RMS when the SpecsIntact Submittal Data File is pulled into RMS)
G	Submittal requires Government Approval	G	GA

DESIGN BID BUILD SUBMITTALS			
BLANK	Submittal is For Information Only (FIO)	BLANK	FIO

1.3.1.2 Government Reviewer Designations

Following the Submittal Classification designation "G", the following reviewer designations may be included:

RO - Resident Office
AO - Area Office
DO - District Office
HNC - Huntsville Engineering and Support Center

Additional information will be provided at the pre-design and/or pre-construction conference.

Corps of Engineers, Omaha District Office for "DO" reviewer designations, submittals will be coordinated through RMS.

1.4 SUBMITTAL CLASSIFICATION

1.4.1 Government Approved (G)

Government approval is required for extensions of design, critical materials, variations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Government.

Within the terms of the Contract Clause SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION, submittals are considered to be "shop drawings."

1.4.2 For Information Only

Submittals not requiring Government approval will be for information only. Within the terms of the Contract Clause SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION, they are not considered to be "shop drawings."

1.4.3 Sustainability Reporting Submittals

Sustainability reporting submittals are as specified in Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

Schedule submittals for these items throughout the course of construction as provided; do not wait until closeout.

1.5 PREPARATION

1.5.1 Transmittal Form

Use the ENG Form 4025 transmittal form for submitting both Government-approved and information-only submittals. Submit in accordance with the instructions on the reverse side of the form. These forms are included in the RMS CM software that the Contractor is required to use for this contract. Properly complete this form by filling out all the heading blank spaces and identifying each item submitted. If there are multiple Item numbers listed on a particular ENG Form 4025 submittal, combine all

submitted items for review into a single Adobe file with bookmarks (for ease of review). Exercise special care to ensure proper listing of the specification paragraph and sheet number of the contract drawings pertinent to the data submitted for each item.

Submittals shall not comingle multiple "Government Reviewer Designations" (see subpart of the same name) on a single ENG Form 4025, nor shall "For Information Only" items (those without a "G" designation on the Submittal Register) be comingled on a common ENG Form 4025 with items containing one of the "Government Reviewer Designations".

1.5.2 Submittal Format

1.5.2.1 General Requirements

When submitting multiple items, clearly identify the pages relevant to the specific items referenced by item number and item name. A cover sheet with the item number and item name immediately before the first page of information pertaining to a given item is acceptable.

On product data cut sheets submitted with multiple variants (models, options, etc.), identify the specific model type(s), option(s), etc., which will be used.

Where multiple parties contribute to the contents of a particular submittal item or logically-group set of items, all items shall be submitted in one cohesive transmittal package for review (that is, portions of items shall not be piecemealed across multiple submittals and/or inappropriately-assigned submittal items). Compilation and aggregation of components necessary for submittals required to an item (group of items identified or necessary for coordinated review) to demonstrate satisfation of the item's/items' contract requirements and the quality control thereof is the responsibility of the contractor. Incomplete submittals will be subject to rejection on the basis of not satisfying all relevant requirements or for submittal of only portions of the requirements.

On re-submittals, the contractor shall include the acknowledgement of and/or response to all comments from the prior submittal, including identification of where changes are made incorporating the review comments. Changes to previously-approved items or subportions of items shall be clearly identified and include a statement regarding the purpose of the change.

Responses or other commentary provided within submittals, requests for information, and similar correspondence shall provide specificity when referencing criteria requirements, past discussions, or past correspondence. Statements such as "per NFPA 70", "per discussion", or "per past RFI"/"per past submittal" are not sufficient; rather, the contractor (or parties subcontracted to assemble documentation and/or correspondence) shall provide the specific criteria section, date of discussion/correspondence, and/or RFI number, submittal number, or other correspondence identifier.

The Contractor Recommendation section of Requests for Information must contain an actionable path forward. RFI Contractor Recommendation sections submitted as blank or containing non-recommendation statements such as "Please advise" are not acceptable.

1.5.2.2 Format of SD-01 Preconstruction Submittals

When the submittal includes a document that is to be used in the project, or is to become part of the project record, other than as a submittal, do not apply the Contractor's approval stamp to the document itself, but to a separate sheet accompanying the document.

Provide data in the unit of measure used in the contract documents.

1.5.2.3 Format for SD-02 Shop Drawings

Provide shop drawings not less than 8 1/2 by 11 inches nor more than 30 by 42 inches, except for full-size patterns or templates. Prepare drawings to accurate size, with scale indicated, unless another form is required. Ensure drawings are suitable for reproduction and of a quality to produce clear, distinct lines and letters, with dark lines on a white background.

a. Include the nameplate data, size, and capacity on drawings. Also include applicable federal, military, industry, and technical society publication references.

b. Dimension drawings, except diagrams and schematic drawings. Prepare drawings demonstrating interface with other trades to scale. Use the same unit of measure for shop drawings as indicated on the contract drawings. Identify materials and products for work shown.

Submit an electronic copy of drawings in PDF format.

1.5.2.3.1 Drawing Identification

Include on each drawing the drawing title, number, date, and revision numbers and dates.

Number drawings in a logical sequence. Each drawing is to bear the number of the submittal in a uniform location next to the title block. Place the Government contract number in the margin, immediately below the title block, for each drawing.

1.5.2.4 Format of SD-03 Product Data

Present product data submittals for each section. Include a table of contents, listing the page and catalog item numbers for product data.

Indicate, by prominent notation, each product that is being submitted; indicate the specification section number and paragraph number to which it pertains.

1.5.2.4.1 Product Information

Supplement product data with material prepared for the project to satisfy the submittal requirements where product data does not exist. Identify this material as developed specifically for the project, with information and format as required for submission of SD-07 Certificates.

Provide product data in units used in the Contract documents. Where product data are included in preprinted catalogs with another unit, submit the dimensions in contract document units, on a separate sheet.

1.5.2.4.2 Standards

Where equipment or materials are specified to conform to industry or technical-society reference standards of such organizations as the American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), or Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. State on the certificate that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5.2.4.3 Data Submission

Collect required data submittals for each specific material, product, unit of work, or system into a single submittal that is marked for choices, options, and portions applicable to the submittal. Mark each copy of the product data identically. Partial submittals will not be accepted for expedition of the construction effort.

Submit the manufacturer's instructions before installation.

1.5.2.5 Format of SD-04 Samples

1.5.2.5.1 Sample Characteristics

Furnish samples in the following sizes, unless otherwise specified or unless the manufacturer has prepackaged samples of approximately the same size as specified:

a. Sample of Equipment or Device: Full size.

b. Sample of Materials Less Than 2 by 3 inches: Built up to 8 1/2 by 11 inches.

c. Sample of Materials Exceeding 8 1/2 by 11 inches: Cut down to 8 1/2 by 11 inches and adequate to indicate color, texture, and material variations.

d. Sample of Linear Devices or Materials: 10 inch length or length to be supplied, if less than 10 inches. Examples of linear devices or materials are conduit and handrails.

e. Sample Volume of Nonsolid Materials: Pint. Examples of nonsolid materials are sand and paint.

f. Color Selection Samples: 2 by 4 inches. Where samples are specified for selection of color, finish, pattern, or texture, submit the full set of available choices for the material or product specified. Sizes and quantities of samples are to represent their respective standard unit.

g. Sample Panel: 4 by 4 feet.

h. Sample Installation: 100 square feet.

1.5.2.5.2 Sample Incorporation

Reusable Samples: Incorporate returned samples into work only if so specified or indicated. Incorporated samples are to be in undamaged condition at the time of use.

Recording of Sample Installation: Note and preserve the notation of any area constituting a sample installation, but remove the notation at the final clean-up of the project.

1.5.2.5.3 Comparison Sample

Samples Showing Range of Variation: Where variations in color, finish, pattern, or texture are unavoidable due to nature of the materials, submit sets of samples of not less than three units showing extremes and middle of range. Mark each unit to describe its relation to the range of the variation.

When color, texture, or pattern is specified by naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.

1.5.2.6 Format of SD-05 Design Data

Provide design data and certificates on 8 1/2 by 11 inch page size.

1.5.2.7 Format of SD-06 Test Reports

By prominent notation, indicate each report in the submittal. Indicate the specification number and paragraph number to which each report pertains.

1.5.2.8 Format of SD-07 Certificates

Provide design data and certificates on 8 1/2 by 11 inch page size.

1.5.2.9 Format of SD-08 Manufacturer's Instructions

Present manufacturer's instructions submittals for each section. Include the manufacturer's name, trade name, place of manufacture, and catalog model or number on product data. Also include applicable federal, military, industry, and technical-society publication references. If supplemental information is needed to clarify the manufacturer's data, submit it as specified for SD-07 Certificates.

Submit the manufacturer's instructions before installation.

1.5.2.9.1 Standards

Where equipment or materials are specified to conform to industry or technical-society reference standards of such organizations as the American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), or Association of Edison Illuminating Companies (AEIC), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the

Contracting Officer. State on the certificate that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5.2.10 Format of SD-09 Manufacturer's Field Reports

By prominent notation, indicate each report in the submittal. Indicate the specification number and paragraph number to which each report pertains.

1.5.2.11 Format of SD-10 Operation and Maintenance Data (O&M)

Comply with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA for O&M Data format.

1.5.2.12 Format of SD-11 Closeout Submittals

When the submittal includes a document that is to be used in the project or is to become part of the project record, other than as a submittal, do not apply the Contractor's approval stamp to the document itself, but to a separate sheet accompanying the document.

Provide data in the unit of measure used in the contract documents.

1.5.3 Source Drawings for Shop Drawings

1.5.3.1 Source Drawings

The entire set of source drawing files (DWG or DGN) will not be provided to the Contractor. Request the specific Drawing Number for the preparation of shop drawings. Only those drawings requested to prepare shop drawings will be provided. These drawings are provided only after award.

1.5.3.2 Terms and Conditions

Data contained on these electronic files must not be used for any purpose other than as a convenience in the preparation of construction data for the referenced project. Any other use or reuse is at the sole risk of the Contractor and without liability or legal exposure to the Government. The Contractor must make no claim, and waives to the fullest extent permitted by law any claim or cause of action of any nature against the Government, its agents, or its subconsultants that may arise out of or in connection with the use of these electronic files. The Contractor must, to the fullest extent permitted by law, indemnify and hold the Government harmless against all damages, liabilities, or costs, including reasonable attorney's fees and defense costs, arising out of or resulting from the use of these electronic files.

These electronic source drawing files are not construction documents. Differences may exist between the source drawing files and the corresponding construction documents. The Government makes no representation regarding the accuracy or completeness of the electronic source drawing files, nor does it make representation to the compatibility of these files with the Contractor hardware or software. The Contractor is responsible for determining if any conflict exists. In the event that a conflict arises between the signed and sealed construction documents prepared by the Government and the furnished source drawing files, the

signed and sealed construction documents govern. Use of these source drawing files does not relieve the Contractor of the duty to fully comply with the contract documents, including and without limitation the need to check, confirm and coordinate the work of all contractors for the project. If the Contractor uses, duplicates or modifies these electronic source drawing files for use in producing construction data related to this contract, remove all previous indication of ownership (seals, logos, signatures, initials and dates).

1.5.4 Electronic File Format

Provide submittals in electronic format, with the exception of material samples required for SD-04 Samples items. Compile the submittal file as a single, complete document, to include the Transmittal Form described within. Name the electronic submittal file specifically according to its contents, and coordinate the file naming convention with the Contracting Officer. Electronic files must be of sufficient quality that all information is legible. Use PDF as the electronic format, unless otherwise specified or directed by the Contracting Officer. All documents must make use of optical character recognition (OCR) routines to make text searchable and selectable, so that the text can be copied. Index and bookmark files exceeding 30 pages to allow efficient navigation of the file. When required, the electronic file must include a valid electronic signature.

E-mail electronic submittal documents smaller than 10MB to an e-mail address as directed by the Contracting Officer, unless directed otherwise by COR. Provide electronic documents over 10 MB on an optical disc or through an electronic file sharing system, such as secure ftp site or DoD SAFE located at the following website: https://safe.apps.mil/. Use of the Government web application must be initiated by the Government, unless Contractor has a Government CAC card. This Government web application restricts the number of days files are available to download.

1.6 QUANTITY OF SUBMITTALS

Submittals are to be transmitted electronically, unless directed otherwise.

1.6.1 Number of SD-04 Samples

a. Submit two samples, or two sets of samples showing the range of variation, of each required item. One approved sample or set of samples will be retained by the approving authority and one will be returned to the Contractor.

b. Submit one sample panel or provide one sample installation where directed. Include components listed in the technical section or as directed.

c. Submit one sample installation, where directed.

d. Submit one sample of nonsolid materials.

1.7 INFORMATION ONLY SUBMITTALS

Submittals without an action code must be certified by the QC manager and submitted to the Contracting Officer for information-only. Approval of the Contracting Officer is not required on information only submittals. The Contracting Officer will mark "receipt acknowledged" on submittals for

information and will return only the transmittal cover sheet to the Contractor. Normally, submittals for information only will not be returned. However, the Government reserves the right to return unsatisfactory submittals and require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe.

1.8 PROJECT SUBMITTAL REGISTER

A sample Project Submittal Register showing submittals required by the specifications is attached to this section as "Project Submittal Register."

1.8.1 Submittal Management

Prepare and maintain a submittal register, as the work progresses. Do not change data that is output in columns (c), (d), (e), and (f) as delivered by Government; retain data that is output in columns (a), (g), (h), and (i) as approved. As an attachment, provide a submittal register showing items of equipment and materials for which submittals are required by the specifications. This list may not be all-inclusive and additional submittals may be required. Maintain a submittal register for the project in accordance with Section 01 45 00.15 10 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE(RMS CM). The Government will provide the initial submittal register in electronic format with the following fields completed, to the extent that will be required by the Government during subsequent usage.

Column (c): Lists specification section in which submittal is required.

Column (d): Lists each submittal description (SD Number. and type, e.g., SD-02 Shop Drawings) required in each specification section.

Column (e): Lists one principal paragraph in each specification section where a material or product is specified. This listing is only to facilitate locating submitted requirements. Do not consider entries in column (e) as limiting the project requirements.

Thereafter, the Contractor is to track all submittals by maintaining a complete list, including completion of all data columns and all dates on which submittals are received by and returned by the Government.

1.8.2 Preconstruction Use of Submittal Register

Submit the submittal register as an electronic database, using the submittal management program furnished to Contractor, unless directed otherwise by COR. Include the QC plan and the project schedule. Verify that all submittals required for the project are listed and add missing submittals. Coordinate and complete the following fields on the register database submitted with the QC plan and the project schedule:

Column (a) Activity Number: Activity number from the project schedule.

Column (g) Contractor Submit Date: Scheduled date for the approving authority to receive submittals.

Column (h) Contractor Approval Date: Date that Contractor needs approval of submittal.

Column (i) Contractor Material: Date that Contractor needs material delivered to Contractor control.

1.8.3 Contractor Use of Submittal Register

Update the following fields in the Government-furnished submittal register program or equivalent fields in the program used by the Contractor with each submittal throughout the contract.

Column (b) Transmittal Number: List of consecutive, Contractor-assigned numbers.

Column (j) Action Code (k): Date of action used to record Contractor's review when forwarding submittals to QC.

Column (l) Date submittal transmitted.

Column (q) Date approval was received.

1.8.4 Approving Authority Use of Submittal Register

Update the following fields:

Column (b) Transmittal Number: List of consecutive, Contractor-assigned numbers.

Column (l) Date submittal was received.

Column (m) through (p) Dates of review actions.

Column (q) Date of return to Contractor.

1.8.5 Action Codes

See paragraph Action Codes above.

1.8.6 Delivery of Copies

Submit an updated electronic copy of the submittal register to the Contracting Officer with each invoice request, unless a paper copy is requested by the Contracting Officer. Provide an updated Submittal Register monthly regardless of whether an invoice is submitted.

1.9 VARIATIONS

Variations from contract requirements require Contracting Officer approval pursuant to contract Clause FAR 52.236-21 Specifications and Drawings for Construction, and will be considered where advantageous to the Government.

1.9.1 Considering Variations

Discussion of variations with the Contracting Officer before submission will help ensure that functional and quality requirements are met and minimize rejections and resubmittals. For variations that include design changes or some material or product substitutions, the Government may require an evaluation and analysis by a licensed professional engineer hired by the contractor. When contemplating a variation that results in lower cost, consider submission of the variation as a Value Engineering Change Proposal (VECP).

Specifically point out variations from contract requirements in transmittal letters. Failure to point out variations may cause the Government to require rejection and removal of such work at no additional cost to the Government.

1.9.2 Proposing Variations

When proposing variations, deliver a written request to the Contracting Officer, with documentation of the nature and features of the variation and why the variation is desirable and beneficial to Government. If lower cost is a benefit, also include an estimate of the cost savings. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

Check the column "variation" of ENG Form 4025 for submittals that include variations proposed by the Contractor. Set forth in writing the reason for any variations and note such variations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted variations.

1.9.3 Warranting that Variations are Compatible

When delivering a variation for approval, the Contractor warrants that this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.

1.9.4 Review Schedule Extension

In addition to the normal submittal review period, a period of 14 calendar days will be allowed for the Government to consider submittals with variations.

1.10 SCHEDULING

Schedule and submit concurrently product data and shop drawings covering component items forming a system or items that are interrelated. Submit pertinent certifications at the same time. No delay damages or time extensions will be allowed for time lost in late submittals. .

a. Coordinate scheduling, sequencing, preparing, and processing of submittals with performance of work so that work will not be delayed by submittal processing. The Contractor is responsible for additional time required for Government reviews resulting from required resubmittals. The review period for each resubmittal is the same as for the initial submittal.

b. Submittals required by the contract documents are listed on the

submittal register. If a submittal is listed in the submittal register but does not pertain to the contract work, the Contractor is to include the submittal in the register and annotate it "N/A" with a brief explanation. Approval by the Contracting Officer does not relieve the Contractor of supplying submittals required by the contract documents but that have been omitted from the register or marked "N/A."

c. Resubmit the submittal register and annotate it monthly with actual submission and approval dates. When all items on the register have been fully approved, no further resubmittal is required.

Contracting Officer review will be completed within 20 calendar days after the date of submission or longer period as identified in the individual specification sections or the relevant "Submittal Coordination and Sequencing Requirements" supbart of this Section, and shall be considered the "normal" review period. However, for submittals delivered to the government on or after the observed day of Veterans Day and on or before the observed day of Martin Luther King, Jr.'s, Birthday (holiday adjustment period), the review period shall be extended by an additional 50% of the number of normal review period calendar days (the extensions for variances shall aggregate to this value without a holiday adjustment).

The Government review period for each construction submittal does not begin until the submittal is delivered via RMS CM. Contract compliance for all submittals are the Contractor's responsibility. Government acceptance or receipt acknowledged does not remove this responsibility for contract compliance on any construction submittal.

1.11 GOVERNMENT APPROVING AUTHORITY

When the approving authority is the Contracting Officer, the Government will:

a. Note the date on which the submittal was received.

b. Review submittals for approval within the scheduling period specified and only for conformance with project design concepts and compliance with contract documents.

c. Identify returned submittals with one of the actions defined in paragraph REVIEW NOTATIONS and with comments and markings appropriate for the action indicated.

Upon completion of review of submittals requiring Government approval, stamp and date submittals. An electronic copy of the submittal will be retained by the Contracting Officer and an electronic copy of the submittal will be returned to the Contractor. The Government may process submittals in the RMS CM System.

1.11.1 Review Notations

Submittals will be returned to the Contractor with the following notations:

a. Submittals marked "approved" or "accepted" authorize proceeding with the work covered.

b. Submittals marked "approved as noted" or "approved, except as noted, resubmittal not required," authorize proceeding with the work covered

provided that the Contractor takes no exception to the corrections.

c. Submittals marked "not approved," "disapproved," or "revise and resubmit" indicate incomplete submittal or noncompliance with the contract requirements or design concept. Resubmit with appropriate changes. Do not proceed with work for this item until the resubmittal is approved.

d. Submittals marked "not reviewed" indicate that the submittal has been previously reviewed and approved, is not required, does not have evidence of being reviewed and approved by Contractor, or is not complete. A submittal marked "not reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals returned for lack of review by Contractor or for being incomplete, with appropriate action, coordination, or change.

e. Submittals marked "receipt acknowledged" indicate that submittals have been received by the Government. This applies only to "information-only submittals" as previously defined.

1.12 DISAPPROVED SUBMITTALS

Make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications, give notice to the Contracting Officer as required under the FAR clause titled CHANGES. The Contractor is responsible for the dimensions and design of connection details and the construction of work. Failure to point out variations may cause the Government to require rejection and removal of such work at the Contractor's expense.

If changes are necessary to submittals, make such revisions and resubmit in accordance with the procedures above. No item of work requiring a submittal change is to be accomplished until the changed submittals are approved.

1.13 APPROVED SUBMITTALS

The Contracting Officer's approval of submittals is not to be construed as a complete check, and indicates only that the general method of construction, materials, detailing, and other information are satisfactory.

Approval or acceptance by the Government for a submittal does not relieve the Contractor of the responsibility for meeting the contract requirements or for any error that may exist, because under the Quality Control (QC) requirements of this contract, the Contractor is responsible for ensuring information contained with in each submittal accurately conforms with the requirements of the contract documents.

After submittals have been approved or accepted by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.14 APPROVED SAMPLES

Approval of a sample is only for the characteristics or use named in such approval and is not be construed to change or modify any contract

requirements. Before submitting samples, provide assurance that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

Match the approved samples for materials and equipment incorporated in the work. If requested, approved samples, including those that may be damaged in testing, will be returned to the Contractor, at its expense, upon completion of the contract. Unapproved samples will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make as that material. The Government reserves the right to disapprove any material or equipment that has previously proved unsatisfactory in service.

Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will automatically void previous approvals. Replace such materials or equipment to meet contract requirements.

1.15 Submittal Coordination and Sequencing Requirements

For any set of submittals identified to be submitted simultaneously for coordinated reviews, if submitted separately, the review period shall start upon receipt of the last submittal (or resubmittal) in the package. Note some items are parts of multiple dependencies.

Where multiple items are identified for the same specifications section, the items shall be submitted under one cover / Form 4025.

1.15.1 Underground Work Coordination at Powerplant

The following items shall be submitted together:

03 30 00 Item: Reinforcing Steel

21 13 13 Item: Shop Drawing

21 13 18 Item: Shop Drawing

26 13 13 Item: Switchgear Drawings
26 13 13 Item: Switchgear

26 20 00 Item: Underground Conduit Routing Plan
26 20 00 Item: Medium- to Low-Voltage Transformers

26 24 13 Item: Switchboard Drawings
26 24 13 Item: Switchboard

27 10 00 Item: Underground Conduit Routing Plan

The bend radii of larger electrical, telecommunications, pump control, and switchgear control conduits and ductbanks preclude routing between the top of the footing and bottom of slab-on-grade and/or create excessive penetrations through grade beams. As such, specially reinforced windows are required in the footing to ensure structural integrity for this

Seismic Risk Category V building.

Additionally, the fire water entrance will require coordination with the footing reinforcement and require substantial completion of the fire suppression systems to evaluate the footing accommodations required to support the requisite riser assemblies.

The coordinated submittals referenced above shall demonstrate with precision representative of products selected to be installed and approved for installation the locations of conduits penetrating the footing, to include the openings in the major electrical equipment permitting underground conduit entrance/exit, as well as any high density of smaller conduits routing underground from panelboards. Any conduit or group of conduits disrupting a 6-inch diameter of footing or slab-on-grade concrete must be detailed. See Sheet S-501.

Approval without resubmittal needs ("A" or "B" action) of all the aforementioned items must occur prior to placement of permanent underground conduits, footings, slab on grade, and grade beams.

Note some electrical submittal items above have additional approval dependencies.

1.15.2 Roof System

The Contractor shall submit the following submittals (and subsequent resubmittals) together:

07 22 00 Item: Insulation Board Layout
07 22 00 Item: Insulation
07 22 00 Item: Cover Board
07 22 00 Item: Fasteners
07 22 00 Item: Wind Resistance
07 22 00 Item: Flame Spread Rating
07 22 00 Item: Installer Qualifications

07 54 19 Item: Detail Drawings
07 54 19 Item: Roof Plan
07 54 19 Item: PVC Roofing Membrane
07 54 19 Item: Wind Uplift Resistance
07 54 19 Items: Membrane Flashing

07 60 00 Item: Gutters
07 60 00 Item: Downspouts
07 60 00 Item: Expansion Joints
07 60 00 Item: Counterflashing
07 60 00 Item: Reglets
07 60 00 Item: Eave Flashing
07 60 00 Item: Finish Samples
07 60 00 Item: Wind Uplift Requirements

Approval without resubmittal needs ("A" or "B" action) of all the aforementioned items must occur prior to installation of the associated item.

1.15.3 Stairs

The Contractor shall submit the following submittals (and subsequent resubmittals) together:

05 51 00 Item: Fabrication Drawings
05 51 00 Item: Steel Pan Stairs
05 51 00 Item: Steel Stairs
05 51 00 Item: Structural Calculations

05 52 00 Item: Fabrication Drawings
05 52 00 Item: Steel Guardrails and Handrails
05 52 00 Item: Design Calculations For Steel Connections

1.15.4 Seismic Protection

The Contractor shall submit the following submittals (and subsequent resubmittals) together:

13 48 73 Item: Bracing
13 48 73 Item: Vibration Isolators
13 48 73 Item: Design Calculations
13 48 73 Item: ICC ES AC156 Shake Table Test

21 13 13 Items: Seismic Bracing

21 13 18 Items: Seismic Bracing

23 05 48.19 Item: Contractor Designed Bracing
23 05 48.19 Item: Coupling and Bracing
23 05 48.19 Item: Equipment Restraint
23 05 48.19 Item: Contractor Designed Bracing
23 05 48.19 Item: Anchor Bolts

26 05 48 Item: Equipment Requirements
26 05 48 Item: Lighting Fixtures
26 05 48 Item: Supports and Attachments
26 05 48 Item: Equipment Requirements
26 05 48 Item: Lighting Fixtures
26 05 48 Item: Flexible Fittings
26 05 48 Item: Anchors
26 05 48 Item: Isolation and Energy Dissipation Systems
26 05 48 Item: Design Calculations
26 05 48 Item: Design Drawings
26 05 48 Item: Independent Design Review Report

Allow a minimum of 30 calendar days exclusive of mailing for Government reviews and approvals.

1.15.5 Fire Protection

The Contractor shall submit the following submittals (and subsequent resubmittals) together:

21 13 13 Item: Sprinkler System Designer
21 13 13 Item: Sprinkler System Installer
21 13 13 Item: Shop Drawing
21 13 13 Item: Hydraulic Calculations
21 13 13 Item: Pipe
21 13 13 Item: Fittings
21 13 13 Item: Valves
21 13 13 Item: Relief Valves
21 13 13 Item: Sprinklers

21 13 13 Item: Pipe Hangers and Supports
21 13 13 Item: Sprinkler Alarm Switch
21 13 13 Item: Valve Supervisory (Tamper) Switch
21 13 13 Item: Fire Department Connection
21 13 13 Item: Backflow Prevention Assembly
21 13 13 Item: Air Vent
21 13 13 Item: Hose Valve

21 13 18 Item: Sprinkler System Designer
21 13 18 Item: Sprinkler System Installer
21 13 18 Item: Releasing System Designer
21 13 18 Item: Releasing System Technician
21 13 18 Item: Releasing System Installer
21 13 18 Item: Nitrogen Generation System Commissioning Technician
21 13 18 Item: Releasing System Site-Specific Software Acknowledgement
21 13 18 Item: Shop Drawing
21 13 18 Item: Wiring Diagrams
21 13 18 Item: Control System Layout
21 13 18 Item: Battery Power (RSCP)
21 13 18 Item: Voltage Drop Calculations (RSCP)
21 13 18 Item: Pipe
21 13 18 Item: Fittings
21 13 18 Item: Valves
21 13 18 Item: Relief Valves
21 13 18 Item: Sprinklers
21 13 18 Item: Pipe Hangers and Supports
21 13 18 Item: Sprinkler Alarm Switch
21 13 18 Item: Valve Supervisory (Tamper) Switch
21 13 18 Item: Fire Department Connection
21 13 18 Item: Backflow Prevention Assembly
21 13 18 Item: Hose Valve
21 13 18 Item: High/Low-Nitrogen Pressure Supervisory Switch
21 13 18 Item: Pre-Action Valve
21 13 18 Item: Nitrogen Generation System
21 13 18 Item: Releasing Service Fire Alarm Control Panel (RSCP)
21 13 18 Item: Terminal Cabinets
21 13 18 Item: Auxiliary Power Supply Panels
21 13 18 Item: Batteries (RSCP)
21 13 18 Item: Battery Chargers
21 13 18 Item: Heat Detectors
21 13 18 Item: Addressable Interface Devices (RSCP)
21 13 18 Item: Addressable Control Modules (RSCP)
21 13 18 Item: Isolation Modules
21 13 18 Item: Surge Protective Devices
21 13 18 Item: Hydraulic Calculations

21 30 00 Item: Fire Protection Specialist
21 30 00 Item: Installation Drawings
21 30 00 Item: Piping Layout
21 30 00 Item: Pump Room
21 30 00 Item: Catalog Data

25 05 11.03 Item: Network Communication Report
25 05 11.03 Item: Cybersecurity Riser Diagram
25 05 11.03 Item: Control System Cybersecurity Documentation
25 05 11.03 Item: Control System Cybersecurity Testing Procedures

28 31 70 Item: Qualified Fire Protection Engineer (QFPE)
28 31 70 Item: Fire alarm system designer

28 31 70 Item: Supervisor
28 31 70 Item: Technician
28 31 70 Item: Installer
28 31 70 Item: Test Technician
28 31 70 Item: Fire Alarm System Site-Specific Software Acknowledgement
28 31 70 Item: Wiring Diagrams
28 31 70 Item: System Layout
28 31 70 Item: Notification Appliances
28 31 70 Item: Initiating devices
28 31 70 Item: Battery Power (Other than RSCP)
28 31 70 Item: Voltage Drop Calculations (Other than RSCP)
28 31 70 Item: Dedicated Emergency Panel Schedules
28 31 70 Item: Fire Alarm Control Unit (FACU)
28 31 70 Item: Releasing Service Fire Alarm Control Panel (RSCP)
28 31 70 Item: LCD Annunciator
28 31 70 Item: Manual Stations
28 31 70 Item: Smoke Detectors
28 31 70 Item: Duct Smoke Detectors
28 31 70 Item: Addressable Interface Devices
28 31 70 Item: Addressable Control Modules
28 31 70 Item: Isolation Modules
28 31 70 Item: Notification Appliances
28 31 70 Item: Batteries
28 31 70 Item: Battery Chargers
28 31 70 Item: Supplemental Notification Appliance Circuit Panels
28 31 70 Item: Level Sensor
28 31 70 Item: Auxiliary Power Supply Panels
28 31 70 Item: Surge Protective Devices
28 31 70 Item: Alarm Wiring
28 31 70 Item: Back Boxes and Conduit
28 31 70 Item: Ceiling Bridges
28 31 70 Item: Terminal Cabinets
28 31 70 Item: Automatic Fire Alarm Transmitters
28 31 70 Item: Radio Transmitter and Interface Panels
28 31 70 Item: Environmental Enclosures or Guards
28 31 70 Item: Hydrogen Detectors
28 31 70 Item: Carbon Monoxide Detectors
28 31 70 Item: Low Temperature Sensors
28 31 70 Item: Solenoid Disconnect Switches
28 31 70 Item: Pressure Switches
28 31 70 Item: Spare Parts
28 31 70 Item: Equipment List

Additionally, the following submittals shall be submitted no later than the first time the above items are submitted:

25 05 11.03 Item: Device Account Lock Exception Request
25 05 11.03 Item: Multiple Ethernet Connection Device Request
25 05 11.03 Item: Contractor Computer Cybersecurity Compliance Statements
25 05 11.03 Item: Contractor Temporary Network Cybersecurity Compliance Statements
25 05 11.03 Item: Resumes and Certifications
Note 25 05 11.03 Item: "Resumes and Certifications" is required to be submitted within 14 days after notice to proceed.

All submittals other than those identified under Section 25 05 11.03 shall be stamped and sealed by the contractor's QFPE. See Section 28 31 70 regarding QFPE qualifications.

Allow a minimum of 40 calendar days exclusive of mailing for Government reviews and approvals.

1.15.6 Adjustable Speed Drives and Associated Equipment

1.15.6.1 Generator Supply Fans

The Contractor shall submit the following submittals (and subsequent resubmittals) together:

23 30 00 Item: Axial Flow Fans
26 29 23 Item: Adjustable Speed Drives (Generator Supply Fans)

1.15.6.2 Other Equipment Requiring Adjustable Speed Drives

Should the contractor determine equipment other than that identified above requires an adjustable speed drive/variable frequency drive, the Contractor shall submit the following submittals (and subsequent resubmittals) together.

1.15.7 Interior Lighting

At a minimum, the following shall be submitted for approval together:

26 51 00 Item: Luminaire Drawings
26 51 00 Item: Luminaires
26 51 00 Item: Light Sources
26 51 00 Item: Luminaire Design Data
26 51 00 Item: LED Drivers
26 51 00 Item: LED Luminaire - ANSI/IES LM-79 Test Report
26 51 00 Item: LED Light Source - ANSI/IES LM-80 Test Report
26 51 00 Item: LED Light Source - ANSI/IES TM-21 Test Report

1.15.8 Exterior Lighting

At a minimum, the following shall be submitted for approval together:

26 56 00 Item: Luminaire Drawings
26 56 00 Item: Pole Drawings
26 56 00 Item: Luminaires
26 56 00 Item: Light Sources
26 56 00 Item: LED Drivers
26 56 00 Item: Photosensors
26 56 00 Item: Poles
26 56 00 Item: Brackets
26 56 00 Item: Luminaire Design Data
26 56 00 Item: ANSI/IES LM-79 Test Report
26 56 00 Item: ANSI/IES LM-80 Test Report
26 56 00 Item: ANSI/IES TM-21 Test Report
26 56 00 Item: Exterior Lighting Control System

1.15.9 Intercommunication System

The Contractor shall submit the following submittals (and subsequent resubmittals) together:

25 05 11.04 Item: Network Communication Report
25 05 11.04 Item: Cybersecurity Riser Diagram

25 05 11.04 Item: Control System Cybersecurity Documentation
25 05 11.04 Item: Control System Cybersecurity Testing Procedures

27 51 23 Item: Installation
27 51 23 Item: All-Call Amplifier
27 51 23 Item: Cone-Type Loudspeakers
27 51 23 Item: Horn-Type Loudspeakers
27 51 23 Item: Intercommunication Amplifier
27 51 23 Item: Master Station
27 51 23 Item: Remote Audio-Only Station
27 51 23 Item: Remote Audio Station
27 51 23 Item: Speaker Enclosures

Additionally, the following submittals shall be submitted no later than the first time the above items are submitted:

25 05 11.04 Item: Device Account Lock Exception Request
25 05 11.04 Item: Multiple Ethernet Connection Device Request
25 05 11.04 Item: Contractor Computer Cybersecurity Compliance Statements
25 05 11.04 Item: Contractor Temporary Network Cybersecurity Compliance Statements
25 05 11.04 Item: Proposed STIG and SRG Applicability Report
25 05 11.04 Item: Resumes and Certifications
Note 25 05 11.04 Item: "Resumes and Certifications" is required to be submitted within 14 days after notice to proceed.

Allow a minimum of 30 calendar days exclusive of mailing for Government reviews and approvals.

1.15.10 HEMP Shield Penetration

Media required to penetrate the Building 433 HEMP shield shall not commence prior to the approval ("A" or "B" Action) of the following submittals:

33 82 00 Item: HEMP Protection Subsystem (Shielding) Specialist
33 82 00 Item: HEMP Measures Shop Drawings

1.15.11 HVAC Controls

The Contractor shall submit the following submittals (and subsequent resubmittals) together:

23 09 00 Item: DDC Contractor Design Drawings

25 05 11.01 Item: Network Communication Report
25 05 11.01 Item: Cybersecurity Riser Diagram
25 05 11.01 Item: Control System Cybersecurity Documentation
25 05 11.01 Item: Control System Cybersecurity Testing Procedures

Additionally, the following submittals shall be submitted no later than the first time the above items are submitted:

25 05 11.01 Item: Device Account Lock Exception Request
25 05 11.01 Item: Multiple Ethernet Connection Device Request
25 05 11.01 Item: Contractor Computer Cybersecurity Compliance Statements
25 05 11.01 Item: Contractor Temporary Network Cybersecurity

Compliance Statements
25 05 11.01 Item: Cybersecurity Interconnection Schedule
25 05 11.01 Item: Proposed STIG and SRG Applicability Report
25 05 11.01 Item: Resumes and Certifications
Note 25 05 11.01 Item: "Resumes and Certifications" is required to be submitted within 14 days after notice to proceed.

Allow a minimum of 30 calendar days exclusive of mailing for Government reviews and approvals.

1.15.12 Fuel Distribution System

The Contractor shall submit the following submittals (and subsequent resubmittals) together:

25 05 11.02 Item: Network Communication Report
25 05 11.02 Item: Cybersecurity Riser Diagram
25 05 11.02 Item: Control System Cybersecurity Documentation
25 05 11.02 Item: Control System Cybersecurity Testing Procedures

33 01 50.31 Items: Leak Detection System (other than O&M Data)
33 01 50.31 Items: Electronic Monitoring/Alarm Panel (other than O&M Data)

33 09 52 Item: Shop Drawing
33 09 52 Item: Laptop Computer
33 09 52 Items: Programmable Logical Controller (PLC) Hardware and Software
33 09 52 Item: Control Wiring Data Lists
33 09 52 Item: Human Machine Interface (HMI)
33 09 52 Item: Fiber Converter Panels (FCP) and Components
33 09 52 Items: Pump Control Panels (PCP) and Components
33 09 52 Item: Graphics Display Screen

33 56 10 Item: Tank Gauges

33 57 55 Items: Meters
33 57 55 Items: Packaged Truck Offload System
33 57 55 Item: Pressure Gages
33 57 55 Item: Differential Pressure Gauge
33 57 55 Item: Automatic Pump Controls
33 57 55 Item: Flow Switches
33 57 55 Item: Submersible Pump
33 57 55 Item: Gear Pump
33 57 55 Item: Packaged Truck Offload System
33 57 55 Item: Liquid Level Gauge
33 57 55 Item: Operating Tank Level Switches

Additionally, the following submittals shall be submitted no later than the first time the above items are submitted:

25 05 11.02 Item: Device Account Lock Exception Request
25 05 11.02 Item: Multiple Ethernet Connection Device Request
25 05 11.02 Item: Contractor Computer Cybersecurity Compliance Statements
25 05 11.02 Item: Contractor Temporary Network Cybersecurity Compliance Statements
25 05 11.02 Item: Cybersecurity Interconnection Schedule
25 05 11.02 Item: Proposed STIG and SRG Applicability Report

25 05 11.02 Item: Resumes and Certifications
Note 25 05 11.02 Item: "Resumes and Certifications" is required to be submitted within 14 days after notice to proceed.

Allow a minimum of 40 calendar days exclusive of mailing for Government reviews and approvals.

1.15.13 Overhead Electric Cranes

The Contractor shall submit the following submittals (and subsequent resubmittals) together:

41 22 13.14 Item: Overhead Electric Traveling Crane
41 22 13.14 Item: Complete Schematic Wiring Diagram
41 22 13.14 Item: Hoists
41 22 13.14 Item: End Stops
41 22 13.14 Item: Variable Frequency Drives
41 22 13.14 Item: Motors
41 22 13.14 Item: Runway Conductor System
41 22 13.14 Item: Bridge Conductor System
41 22 13.14 Item: Limit Switches
41 22 13.14 Item: Pendant Pushbutton Station
41 22 13.14 Item: Controls
41 22 13.14 Item: Control Parameter Settings
41 22 13.14 Item: Capacity Overload Protective Device
41 22 13.14 Item: Load and Sizing Calculations

1.15.14 Electrical Equipment Supporting Fire Protection

1.15.14.1 Transformers for Electric Fire Pumps

The transformers associated with the electric fire pump shall not be approved for installed equipment suitability prior to the approval of the Section 21 30 00 Fire Pump sized to satisfy the needs of suppression systems performance based on the hydraulic calculations of Sections 21 13 13 and 21 13 18.

21 13 13 Item: Hydraulic Calculations

21 13 18 Item: Hydraulic Calculations

21 30 00 Item: Installation Drawings
21 30 00 Item: Catalog Data

26 12 19.10 Items: Pad-mounted Transformer Drawings (Fire Pump)

1.15.14.2 Non-Fire Pump Features

Approval of 26 20 00 Item: "Panelboards" for Panels NFL and NL will not be considered without the approval of the following submittal item, which requires a complete design of the fire alarm and suppression systems:

28 31 70 Item: Dedicated Emergency Panel Schedules

Provide the following as required by individual panelboard, transformer, enclosed circuit breaker, and/or automatic transfer switch supporting contractor-furnished items:

26 20 00 Item: Interim CFCI Equipment Electrical Data (Fire Alarm)

1.15.15 Generation, Distribution, and Controls (Medium Voltage plus Switchboards)

The Contractor shall submit the following submittals (and subsequent resubmittals) together with respect to control equipment/devices and interfaces:

25 05 11.05 Item: Network Communication Report
25 05 11.05 Item: Cybersecurity Riser Diagram
25 05 11.05 Item: Control System Cybersecurity Documentation
25 05 11.05 Item: Control System Cybersecurity Testing Procedures

26 05 73 Item: Interim Load Flow Study
26 05 73 Item: Interim Fault Current Analysis
26 05 73 Item: Interim Protective Device Coordination Study
26 05 73 Item: Transformer Inrush Data

26 13 01 Item: Switchgear Drawings
26 13 01 Item: Fuse Time-Current Characteristic Curves
26 13 01 Item: Air Insulated Pad-mounted Switchgear
26 13 01 Item: Insulated High-Voltage Connectors
26 13 01 Item: Surge Arresters

26 13 13 Item: Switchgear Drawings
26 13 13 Item: Switchgear
26 13 13 Item: Generator Controls Sequence of Operations

26 20 00 Item: Metering
26 20 00 Item: Circuit Breakers (Switchboards)
26 20 00 Item: Busway

26 24 13 Item: Switchboard Drawings
26 24 13 Item: Switchboard

26 32 15 Item: Engine-Generator Set and Auxiliary Equipment
26 32 15 Item: Auxiliary Systems
26 32 15 Item: Detailed Drawings
26 32 15 Item: Harmonic Requirements
26 32 15 Item: Engine-Generator Set Efficiencies
26 32 15 Item: Emissions
26 32 15 Item: Filters
26 32 15 Item: Engine-Generator Parameter Schedule
26 32 15 Item: Exchanger
26 32 15 Item: Generator
26 32 15 Item: Vibration-Isolation
26 32 15 Item: Exciter
26 32 15 Item: Performance Criteria
26 32 15 Item: Heat Exchanger
26 32 15 Item: Time-Delay on Alarms
26 32 15 Item: Cooling System
26 32 15 Item: Vibration Isolation
26 32 15 Item: Battery Charger
26 32 15 Item: Capacity Calculations for Engine-Generator Set
26 32 15 Item: Brake Mean Effective Pressure (BMEP) Calculations
26 32 15 Item: Torsional Vibration Stress Analysis Computations
26 32 15 Item: Turbocharger Load Calculations

Additionally, the following submittals shall be submitted no later than

the first time the above items are submitted:

25 05 11.05 Item: Device Account Lock Exception Request
25 05 11.05 Item: Multiple Ethernet Connection Device Request
25 05 11.05 Item: Contractor Computer Cybersecurity Compliance Statements
25 05 11.05 Item: Contractor Temporary Network Cybersecurity Compliance Statements
25 05 11.05 Item: Cybersecurity Interconnection Schedule
25 05 11.05 Item: Proposed STIG and SRG Applicability Report
25 05 11.05 Item: Resumes and Certifications
Note 25 05 11.05 Item: "Resumes and Certifications" is required to be submitted within 14 days after notice to proceed.

The Contractor shall not submit nor shall submittals be considered approved for installation on any electrical equipment containing overcurrent protective devices or requiring a short circuit rating or an arc flash rating until the Power System Studies (Section 26 05 73) has been submitted for review by the Contractor and until it has been approved (transmittal "A" or "B" Action) by the reviewing agent. However, a conservative utility available fault value may be used for an interim study suitable to release equipment, however, true values must be used for establishing equipment available fault current and arc flash labeling. See Section 26 05 73.

Allow a minimum of 40 calendar days exclusive of mailing for Government reviews and approvals.

1.15.16 Electrical Distribution Equipment (Downstream of Switchboards)

The Contractor shall submit the following submittals (and subsequent resubmittals) together:

26 05 73 Item: Interim Load Flow Study
26 05 73 Item: Interim Fault Current Analysis
26 05 73 Item: Interim Protective Device Coordination Study
26 05 73 Item: Transformer Inrush Data

26 20 00 Item: Panelboards
26 20 00 Item: Circuit Breakers (Other than Switchboards)
26 20 00 Item: Switches
26 20 00 Item: Manual Transfer Switch
26 20 00 Item: Low- to Low-Voltage Transformers
26 20 00 Item: Enclosed Circuit Breakers
26 20 00 Item: Adjustable Circuit Breaker Settings Cover
26 20 00 Item: Circuit Breaker Handle Locks and Lock-out Device
26 20 00 Item: Conductor Termination Adapters

26 36 23 Item: Automatic Transfer Switch Drawings
26 36 23 Item: Automatic Transfer Switches
26 36 23 Item: By-Pass/Isolation Switch (BP/IS)

Provide the following as required by individual panelboard, transformer, enclosed circuit breaker, and/or automatic transfer switch supporting contractor-furnished items:

26 20 00 Item: Interim CFCI Equipment Electrical Data
26 20 00 Item: CFCI Equipment Electrical Data

Submittals may be further subdivided for approval of logically-grouped equipment with supporting information such as follows:

1. Generator Station Service Panelboards with 26 20 00 Item "Interim CFCI Equipment Electrical Data (Generator Station Service)"
2. Filter Shelter distribution equpment with 26 20 00 Item "Interim CFCI Equipment Electrical Data (Filter Shelter)"
3. Offload distribution equpment with 26 20 00 Item "Interim CFCI Equipment Electrical Data (Offload)" and congruently the 26 05 73 Items for Interim Studies for the Offload.

The Contractor shall not submit nor shall submittals be considered approved for installation on any electrical equipment containing overcurrent protective devices or requiring a short circuit rating or an arc flash rating until the Power System Studies (Section 26 05 73) has been submitted for review by the Contractor and until it has been approved (transmittal "A" or "B" Action) by the reviewing agent. However, a conservative utility available fault value may be used for an interim study suitable to release equipment, however, true values must be used for establishing equipment available fault current and arc flash labeling. See Section 26 05 73.

Allow a minimum of 40 calendar days exclusive of mailing for Government reviews and approvals.

1.16 Contractor-Furnished Items Requiring Electrical Interface

Any contractor-furnished devices and equipments requiring interface with the electrical distribution system shall be accounted for in the "CFCI Equipment Electrical Data" submittal(s).

When submitting products requiring such interface, provide in the submittal a summary of the characteristics required by the Section 26 20 00 "CFCI Equipment Electrical Data" submittal, and provide in the submittal manufacturer documentation expressing the electrical supply needs.

Specification sections containing contractor-furnished items anticipated to require electrical interface have been identified in the contract documents, with an attempt to consolidate in the EP610 series Equipment Electrical Connection Schedules. However, should additional contractor-furnished items require the support described in this subpart, the contractor shall furnish for such items the information required herein.

See Section 26 20 00 for additional instructions.

1.17 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

1.18 CERTIFICATION OF SUBMITTAL DATA

Certify the submittal data as follows on Form ENG 4025: "I certify that the above submitted items had been reviewed in detail and are correct and in strict conformance with the contract drawings and specifications except as otherwise stated.

_____NAME OF CONTRACTOR _____ SIGNATURE OF CONTRACTOR

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Power Independence, Mission Control Station - Buckley SFB, CO

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION	MAILED TO CONTR/ DATE RCD FRM APPR AUTH	
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 14 00	SD-01 Preconstruction Submittals															
			Project Security And Site Access	1.5	G	RO												
			Management Plan															
		01 30 00.24	SD-01 Preconstruction Submittals															
			List Of Contact Personnel	1.22.2.1														
			VIEW LOCATION MAP	1.16														
			PROGRESS AND COMPLETION	1.17														
			PICTURES															
			SD-02 Shop Drawings															
			Equipment Room Drawings	1.29	G	RO												
			SD-11 Closeout Submittals															
			Interim DD Form 1354	1.39.1	G	RO												
			List Of Installed Building	1.39.2														
			Equipment Items For Dd Form															
			1354															
		01 32 01.00 10	SD-01 Preconstruction Submittals															
			Project Scheduler Qualifications	1.3	G	RO												
			Preliminary Project Schedule	3.4.1	G	RO												
			Initial Project Schedule	3.4.2	G	RO												
			Periodic Schedule Update	3.6.2	G	RO												
		01 33 00	SD-01 Preconstruction Submittals															
			Submittal Register	1.8	G	RO												
		01 33 29	SD-11 Closeout Submittals															
			Final High Performance and	3.1	G	RO												
			Sustainable Building Checklist															
		01 33 39.00 10	SD-01 Preconstruction Submittals															

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
Power Independence, Mission Control Station - Buckley SFB, CO

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)		(q)	(r)
		01 33 39.00 10	Advanced Modeling Project	1.4.1	G	DO													
			Execution Plan (PxP)																
			PxP Demonstration	1.4.2	G	RO													
		01 35 26	SD-01 Preconstruction Submittals																
			Accident Prevention Plan (APP)	1.8	G	RO													
			Indoor Air Quality (IAQ)	1.16	G	RO													
			Management Plan																
			SD-06 Test Reports																
			Accident Reports	1.12.2	G	RO													
			LHE Inspection Reports	1.12.3															
			Monthly Exposure Reports	1.5	G	RO													
			SD-07 Certificates																
			Activity Hazard Analysis (AHA)	1.9	G	RO													
			Certificate of Compliance	1.12.4															
			Hot Work Permit	1.13															
			License Certificates	1.14															
			Portable Gauge Operations	1.14.1	G	RO													
			Planning Worksheet																
			Radiography Operation Planning	1.14.1	G	RO													
			Work Sheet																
			Standard Lift Plan	1.12.4	G	RO													
			Critical Lift Plan	1.12.4	G	RO													
		01 41 26.05 24	SD-01 Preconstruction Submittals																
			Inspector Qualifications	3.2.4.1															
			Inspection Certification	3.2.4.1															
			Stormwater Notice Of Intent	3.2.1	G	RO													

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Power Independence, Mission Control Station - Buckley SFB, CO

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
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		01 41 26.05 24	Stormwater Pollution Prevention	3.2.2.1	G	RO													
			Plan																
			SD-11 Closeout Submittals																
			Stormwater Notice Of	3.2.6	G	RO													
			Termination																
		01 45 00	SD-01 Preconstruction Submittals																
			Contractor Quality Control (CQC)	1.5.2	G	RO													
			Plan																
			SD-06 Test Reports																
			Verification Statement	1.12.3															
			SD-07 Certificates																
			Certificate Of Readiness	1.6.5.1	G	RO													
		01 45 35	SD-01 Preconstruction Submittals																
			SIOR Letter of Acceptance	3.1.1	G	RO													
			Project Manual	3.1.1	G	RO													
			Project Manual	3.1.1	G	RO													
			NDT Procedures and Equipment	3.1.1															
			Calibration Records																
			SD-06 Test Reports																
			Daily Reports	3.1.1															
			Daily Reports	3.1.3															
			Daily Reports	3.1.3															
			Biweekly Reports	3.1.1															
			SD-07 Certificates																
			Fabrication Plant	2.1															
			Steel Joist Institute Membership	2.1															

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		01 45 35	Certified Plant	2.1															
			Certificate of Compliance	2.1															
			Special Inspector of Record	1.5.9															
			Special Inspector	1.5															
			Qualification Records	3.1.1															
			SD-11 Closeout Submittals																
			Comprehensive Final Report	3.1.1	G	RO													
			Comprehensive Final Report	3.1.3	G	RO													
		01 50 00	SD-01 Preconstruction Submittals																
			Construction Site Plan	1.3	G	RO													
			Traffic Control Plan	3.3.1	G	RO													
			Haul Road Plan	2.2.1	G	RO													
			Contractor Computer	1.6.1.4	G	RO													
			Cybersecurity Compliance																
			Statements																
			Contractor Temporary Network	1.6.6	G	RO													
			Cybersecurity Compliance																
			Statements																
			SD-06 Test Reports																
			Backflow Preventer Tests	3.4															
			SD-07 Certificates																
			Backflow Tester	1.4.1															
			Backflow Preventers	1.4															
		01 57 20.00 10	SD-01 Preconstruction Submittals																
			Environmental Protection Plan	1.8	G	RO													

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		01 57 20.00 10	Demolition Notification	1.7.2														
			Application Form															
			Spill Prevention Control and	3.17.2	G	RO												
			Countermeasure (SPCC) Plan															
			SD-07 Certificates															
			Monthly Hazardous Material	3.8.2														
			Tracking Report															
		01 57 23	SD-07 Certificates															
			Mill Certificate or Affidavit	2.1.3														
		01 74 19	SD-01 Preconstruction Submittals															
			Construction Waste Management	1.6	G	RO												
			Plan															
			SD-11 Closeout Submittals															
			Final Construction Waste	1.8	G	RO												
			Diversion Report															
		01 78 23	SD-10 Operation and Maintenance															
			Data															
			Training Plan	3.1.1	G	RO												
			Training Outline	3.1.3	G	RO												
			Training Content	3.1.2	G	RO												
			Operation And Maintenance	3.2.1	G	RO												
			Manual, Progress Submittal															
			Operation And Maintenance	3.2.2	G	RO												
			Manual, Prefinal Submittal															
			Operation And Maintenance	3.2.3	G	RO												
			Manual, Final Submittal															

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		01 78 23	SD-11 Closeout Submittals																
			Training Video Recording	3.1.4	G	RO													
			Validation of Training Completion	3.1.6	G	RO													
			Training Plan	3.1.1	G	RO													
			Record Drawings And Utility	1.7.6.7	G	RO													
			Systems																
			FACILITY DATA WORKBOOK	1.5	G	RO													
		01 78 23.33	SD-10 Operation and Maintenance																
			Data																
			System Instructions	2.1.1	G	RO													
		01 78 24.00 10	SD-01 Preconstruction Submittals																
			Facility Data Project Execution	1.5.1	G	DO													
			Plan																
			SD-10 Operation and Maintenance																
			Data																
			Facility Data Workbook,	3.1	G	RO													
			Construction Progress																
			Facility Document Set,	3.1	G	RO													
			Construction Progress																
			SD-11 Closeout Submittals																
			Facility Data Workbook,	3.2	G	RO													
			Construction Final																
			Facility Document Set,	1.5.3	G	RO													
			Construction Final																
			Facility Document Set,	3.2	G	RO													
			Construction Final																

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		01 78 36.00 24	SD-11 Closeout Submittals															
			Equipment Warranty Booklet	1.2.5														
		01 78 39.00 24	SD-03 Product Data															
			50 Percent Preliminary As-Built	1.8.2	G	RO												
			Drawings															
			100 Percent Preliminary As-Built	1.8.3	G	RO												
			Drawings															
			SD-11 Closeout Submittals															
			Final As-Built Drawings	1.8.4	G	RO												
			Sustainability Documentation	1.5.4	G	RO												
		01 91 00.15	SD-06 Test Reports															
			Completed Construction	3.6	G	RO												
			Observation Checklists															
			Design Review Report	3.1	G	DO												
			Interim Construction Phase	3.5	G	RO												
			Commissioning Plan															
			Final Construction Phase	3.5	G	RO												
			Commissioning Plan															
			Issues Log	1.11	G	DO												
			SD-07 Certificates															
			Commissioning Firm	1.9	G	RO												
			Certificate of Readiness	1.12	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Maintenance and Service Life	3.10	G	RO												
			Plan															

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		01 91 00.15	Systems Manual	3.9	G	RO												
			SD-11 Closeout Submittals															
			Final Commissioning Report	3.11	G	RO												
			Updated Final Commissioning Report	3.12	G	RO												
		02 41 00	SD-01 Preconstruction Submittals															
			Demolition/Deconstruction Plan	1.2.2	G	RO												
			Existing Conditions	1.9														
			SD-07 Certificates															
			Notification	1.7	G	RO												
		02 61 13	SD-01 Preconstruction Submittals															
			Work Plan	1.2	G	RO												
			SD-06 Test Reports															
			Closure Report	3.8	G	RO												
		02 82 00	SD-03 Product Data															
			Amended Water	1.2.2	G	RO												
			Safety Data Sheets (SDS) for All Materials	1.3.9	G	RO												
			Respirators	3.1.2.1	G	RO												
			Local Exhaust Equipment	3.1.7	G	RO												
			Pressure Differential Automatic Recording Instrument	3.1.7	G	RO												
			Vacuums	3.1.8	G	RO												
			Glovebags	3.1.10	G	RO												
			SD-06 Test Reports															
			Air Sampling Results	1.5.5	G	RO												

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		02 82 00	Pressure Differential Recordings	1.5.6	G	RO												
			for Local Exhaust System															
			Clearance Sampling	3.2.9.4	G	RO												
			SD-07 Certificates															
			Employee Training	1.3.4	G	RO												
			Notifications	1.3.5	G	RO												
			Respiratory Protection Program	1.3.7	G	RO												
			Asbestos Hazard Abatement Plan	1.3.10	G	RO												
			Testing Laboratory	1.3.11	G	RO												
			Landfill Approval	1.3.12	G	RO												
			Delivery Tickets	1.3.12	G	RO												
			Waste Shipment Records	1.3.12	G	RO												
			Transporter Certification	1.3.13	G	RO												
			Medical Certification	1.3.14	G	RO												
			Private Qualified Person	1.5.1	G	RO												
			Documentation															
			Designated Competent Person	1.5.2	G	RO												
			Worker's License	1.5.3	G	RO												
			Contractor's License	1.5.4	G	RO												
			Equipment Used to Contain	3.1	G	RO												
			Airborne Asbestos Fibers															
			Water Filtration Equipment	3.1.3.3	G	RO												
			Vacuums	3.1.8	G	RO												
			Ventilation Systems	3.1.8	G	RO												
			SD-11 Closeout Submittals															
			Permits	1.3.5	G	RO												

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		02 82 00	Notifications	1.3.5	G	RO												
			Respirator Program Records	1.3.7.1	G	RO												
			Rental Equipment	1.7.1	G	RO												
		02 83 00	SD-01 Preconstruction Submittals															
			Lead Waste Management Plan	1.5.2.4	G	RO												
			Lead Compliance Plan	1.5.2.2	G	RO												
			Materials and Equipment	2.1	G	RO												
			Expendable Supplies	2.1.1	G	RO												
			Sampling and Analysis	1.3.3	G	RO												
			SD-11 Closeout Submittals															
			Hazardous Waste Manifest	3.4.2.1	G	RO												
			Turn-In Documents or Weight Tickets	3.4.2.1	G	RO												
		02 84 16	SD-07 Certificates															
			PCB and Lamp Removal Work Plan	1.8.1	G	RO												
			PCB and Lamp Disposal Plan	1.8.2	G	RO												
			SD-11 Closeout Submittals															
			Transporter Certification	3.5.2	G	RO												
			Certification of Decontamination	3.2.4														
			Certificate of Disposal and/or recycling	3.5.2.1														
		03 30 00	SD-01 Preconstruction Submittals															
			Quality Control Program	1.6.4	G	RO												
			Quality Control Personnel Certifications	1.6.5	G	RO												

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		03 30 00	Quality Control Organizational	1.6.5															
			Chart																
			Laboratory Accreditation	1.6.7	G	RO													
			Maturity Method Data	3.3.10															
			SD-02 Shop Drawings																
			Reinforcing Steel	1.6.2.1	G	DO													
			SD-03 Product Data																
			Joint Sealants	2.4.5															
			Joint Filler	2.4.4															
			Formwork Materials	2.1															
			Recycled Aggregate Materials	2.3.3.3															
			Cementitious Materials	2.3.1															
			Vapor Barrier	2.4.6															
			Concrete Curing Materials	2.4.1															
			Reinforcement	2.6															
			Liquid Chemical Floor Hardeners	2.4.3.1															
			and Sealers																
			Admixtures	2.3.4															
			Mechanical Reinforcing Bar	2.6.2															
			Connectors																
			Local/Regional Materials	1.8.1															
			Biodegradable Form Release	2.2.2															
			Agent																
			Nonshrink Grout	2.4.2															
			SD-05 Design Data																
			Concrete Mix Design	1.6.1.1	G	DO													

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		03 30 00	SD-06 Test Reports																
			Concrete Mix Design	1.6.1.1	G	DO													
			Fly Ash	1.6.3.1															
			Pozzolan	1.6.3.1															
			Slag Cement	1.6.3.2															
			Aggregates	1.6.3.3															
			Compressive Strength Tests	3.12.3.3	G	DO													
			Slump Tests	3.12.3.1															
			Water	2.3.2															
			SD-07 Certificates																
			Reinforcing Bars	2.6.1															
			Welder Qualifications	1.9															
			Forest Stewardship Council	1.8.2															
			(FSC) Certification																
			Field Testing Technician and	1.6.5.2															
			Testing Agency																
			SD-08 Manufacturer’s Instructions																
			Liquid Chemical Floor Hardeners	2.4.3.1															
			and Sealers																
			Joint Sealants	2.4.5															
			Curing Compound	2.4.1															
		03 45 00	SD-01 Preconstruction Submittals																
			Pre-Installation Meeting	1.12.4															
			SD-02 Shop Drawings																
			Precast Drawings	1.12.1	G	DO													
			SD-03 Product Data																

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		03 45 00	Cast-In Embedded Items And	2.3	G	DO												
			Connectors															
			Connection Devices	2.3.2	G	DO												
			Admixtures	2.2.6														
			Gasket	2.5	G	RO												
			Bearing Pads	2.7														
			SD-04 Samples															
			Concrete Wall Panel Surface	1.12.2	G	RO												
			Finish															
			SD-05 Design Data															
			Design Calculations	1.5.4	G	DO												
			Contractor-Furnished Mix Design	2.1.1														
			Repair of Surface Defects	2.4.9														
			Thermal Calculations	1.5.5														
			SD-06 Test Reports															
			Strength Tests	1.11.2	G	DO												
			Slump	1.11.2														
			Air Content	1.11.2														
			Test for Concrete Materials	1.11.1														
			Water	2.2.7														
			Testing Precast Units for Strength	3.6.4														
			SD-07 Certificates															
			Manufacturer's Qualifications	1.4	G	RO												
			Fabricator Quality Certifications	1.8.1														
			Erector Certification	1.9														
			Erector's Post Audit Declaration	1.10														

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		03 45 00	SD-08 Manufacturer's Instructions															
			Installation	3.3	G	RO												
			Cleaning	3.8														
			SD-11 Closeout Submittals															
			Batch Ticket Information	1.12.3														
			Recycled Content for Fly Ash and	2.2.1														
			Pozzolan															
			Recycled Content for Ground Iron	2.2.1														
			Blast-Furnace Slag															
			Recycled Content for Silica Fume	2.2.1														
		05 05 20	SD-01 Preconstruction Submittals															
			Installer Qualifications	1.5.1.1	G	RO												
			Post-Installed Anchor Special	1.5.1.2	G	RO												
			Inspector Qualifications															
			SD-03 Product Data															
			Mechanical Anchors in Concrete	2.1.1.3														
			Adhesive Anchor System in	2.1.1.4														
			Concrete															
			Mechanical and Adhesive	2.1.1.5														
			Anchors in Masonry															
			Non-Shrink, Non-Metallic Grout	3.1.3														
			SD-06 Test Reports															
			Post-Installed Anchor Special	3.3.4	G	RO												
			Inspections Report															
			SD-07 Certificates															

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		05 05 20	Post-Installed Anchor	2.1.1.1	G	RO													
			Certification																
			SD-08 Manufacturer’s Instructions																
			Manufacturer's Printed	2.1.1.2															
			Installation Instructions																
			Non-Shrink, Non-Metallic Grout	3.1.3															
			Manufacturer's Safety Data	1.5															
			Sheets																
		05 05 23.16	SD-01 Preconstruction Submittals																
			Welding Quality Assurance Plan	3.2	G	RO													
			SD-03 Product Data																
			Welding Procedure Qualifications	1.3	G	RO													
			Welder, Welding Operator, and	1.3.4															
			Tacker Qualification																
			Previous Qualifications	1.3.2															
			Pre-Qualified Procedures	1.3.3	G	RO													
			Welding Electrodes and Rods	2.2															
			SD-06 Test Reports																
			Nondestructive Testing	3.3															
			Weld Inspection Log	3.2															
			SD-07 Certificates																
			Certified Welding Procedure	1.3.1															
			Specifications (WPS)																
			Certified Brazing Procedure	1.3.1															
			Specifications (BPS)																

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		05 05 23.16	Certified Procedure Qualification	1.3.1															
			Records (PQR)																
			Certified Welder Performance	1.3.1															
			Qualifications (WPQ)																
			Certified Brazer Performance	1.3.1															
			Qualifications (BPQ)																
			Certified Welding Inspector	1.3.5															
			Nondestructive Testing Personnel	1.3.5															
		05 12 00	SD-01 Preconstruction Submittals																
			Erection and Erection Bracing	1.5.1.1	G	DO													
			Drawings																
			SD-02 Shop Drawings																
			Fabrication Drawings	1.5.2	G	DO													
			SD-03 Product Data																
			Shop Primer	2.6.2															
			Welding Electrodes and Rods	2.4.1															
			Direct Tension Indicator Washers	2.3.2.3															
			Non-Shrink Grout	2.4.2															
			Tension Control Bolts																
			Recycled Content for Structural	2.2.1															
			Steel																
			Recycled Content for Structural	2.2.2															
			Steel Tubing																
			Recycled Content for Steel Pipe	2.2.3															
			SD-05 Design Data																
			Shoring and Temporary Bracing	1.5.2															

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		05 12 00	SD-06 Test Reports																
			Class B Coating	2.6.2															
			Bolts, Nuts, and Washers	2.3															
			Weld Inspection Reports	3.7.1.2															
			Direct Tension Indicator Washer	3.7.2.1															
			Inspection Reports																
			Bolt Testing Reports	3.7.3.1															
			SD-07 Certificates																
			Steel	2.2															
			Bolts, Nuts, and Washers	2.3															
			Galvanizing	2.5															
			AISC Structural Steel Fabricator	1.3															
			Quality Certification																
			AISC Structural Steel Erector	1.3															
			Quality Certification																
			Welding Procedures and	1.5.3.1															
			Qualifications																
			Welding Electrodes and Rods	2.4.1															
			Certified Welding Inspector	3.7.1.1															
			NDT Technician	3.7.1.2															
			Welding Procedure Specifications	3.4															
			(WPS)																
			Overhead, Top Running Crane	1.5.3.2															
			Rail Beam																
		05 21 00	SD-01 Preconstruction Submittals																
			Welder Qualification	1.3.2															

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		05 21 00	SD-02 Shop Drawings																
			Steel Joist Framing	1.3.1	G	DO													
			SD-03 Product Data																
			Recycled Content Of Steel	2.3															
			Products																
			SD-05 Design Data																
			Design Calculations	2.2	G	DO													
			SD-06 Test Reports																
			Erection Inspection;	3.4	G	RO													
			Welding Inspections;	3.4	G	RO													
			SD-07 Certificates																
			Certification of Compliance;	1.3.2	G	RO													
		05 30 00	SD-02 Shop Drawings																
			Fabrication Drawings	1.3.5	G	DO													
			SD-03 Product Data																
			Accessories	2.2															
			Deck Units	2.1															
			Galvanizing Repair Paint	3.2.4.1															
			Galvanizing Repair Paint	3.2.4.2															
			Touch-Up Paint	2.1.5															
			Welding Equipment	1.3.3															
			Welding Rods and Accessories	1.3.3															
			Recycled Content of Steel	2.1															
			Products																
			SD-04 Samples																
			Metal Roof Deck Units	2.1.1															

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		05 30 00	Flexible Closure Strips	2.2.4															
			SD-05 Design Data																
			Deck Units	2.1	G	DO													
			SD-07 Certificates																
			Powder-Actuated Tool Operator	1.3.2															
			Welder Qualifications	1.3.3															
			Welding Procedures	1.3.3															
			Fire Safety	1.3.4.1															
			Wind Storm Resistance	1.3.4.2															
			Manufacturer's Certificate	1.3.1															
			Stud Manufacture's Certification	2.2.12															
			Stud Manufacture's Test Reports	2.2.12															
		05 40 00	SD-02 Shop Drawings																
			Framing Components	1.6.1	G	DO													
			SD-03 Product Data																
			Studs, Joists	2.1															
			Recycled Content of Steel	2.1	G	RO													
			Products																
			SD-05 Design Data																
			Metal Framing Calculations	1.6.2	G	DO													
			SD-07 Certificates																
			Load-Bearing Cold-Formed Metal	1.4															
			Framing																
			Welds	3.2.1															
		05 50 13	SD-02 Shop Drawings																
			Floor Gratings	2.3	G	DO													

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		05 50 13	Bollards/Pipe Guards	2.4	G	DO													
			Roof Hatch Guards and Gate	2.6	G	DO													
			Angles and Plates	2.5	G	DO													
			Roof Hatch	2.6	G	RO													
			Roof Hatch	2.6	G	RO													
			SD-03 Product Data																
			Floor Gratings	2.3	G	DO													
			Roof Hatch	2.6	G	DO													
			Roof Hatch	2.6	G	DO													
			Roof Hatch Guards and Gate	2.6	G	DO													
		05 51 00	SD-02 Shop Drawings																
			Fabrication Drawings	1.4.1	G	DO													
			SD-03 Product Data																
			Steel Pan Stairs	2.2.2	G	DO													
			Steel Stairs	2.3.1	G	DO													
			SD-05 Design Data																
			Structural Calculations	1.4.2	G	DO													
			SD-07 Certificates																
			Welding Procedures	1.3.1	G	RO													
			Welder Qualification	1.3.1	G	RO													
		05 51 33	SD-02 Shop Drawings																
			Ladders	2.3	G	DO													
			SD-07 Certificates																
			Fabricator Certification for Ladder Assembly	1.4															
		05 52 00	SD-02 Shop Drawings																

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		05 52 00	Fabrication Drawings	1.4.1	G	DO													
			SD-03 Product Data																
			Concrete Inserts	2.2.7															
			Steel Guardrails and Handrails	2.2.9	G	DO													
			Anchorage and Fastening	2.1															
			Systems																
			SD-05 Design Data																
			Design Calculations For Steel	1.4.2	G	DO													
			Connections																
			SD-06 Test Reports																
			Welding Inspections	1.3.1	G	RO													
			SD-07 Certificates																
			Welder Qualification	1.3.2	G	RO													
		06 10 00	SD-02 Shop Drawings																
			Nailing Strips	2.2.1.1															
			SD-03 Product Data																
			Fire-retardant Treatment	1.8															
			Adhesives	2.2.2															
			SD-06 Test Reports																
			Preservative-treated	1.4.3															
			SD-07 Certificates																
			Certificates of Grade	1.9.1															
			Preservative Treatment	1.7															
		07 22 00	SD-02 Shop Drawings																
			Insulation Board Layout	1.3	G	DO													
			SD-03 Product Data																

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		07 22 00	Insulation	2.1	G	DO												
			Cover Board	1.4	G	DO												
			Fasteners	2.3	G	DO												
			Recycled Content For Insulation	2.1.2														
			SD-05 Design Data															
			Wind Resistance	1.7	G	DO												
			SD-06 Test Reports															
			Flame Spread Rating	1.8.1	G	DO												
			SD-07 Certificates															
			Installer Qualifications	1.6	G	DO												
			SD-08 Manufacturer’s Instructions															
			Fasteners	2.3														
			Insulation	2.1														
		07 27 10	SD-02 Shop Drawings															
			Air Barrier System Shop	2.1	G	DO												
			Drawings															
			SD-03 Product Data															
			Air Barrier System Product Data	2.1	G	DO												
			SD-06 Test Reports															
			Inspection Report	3.1.2	G	RO												
		07 54 19	SD-02 Shop Drawings															
			Detail Drawings	1.6	G	DO												
			Roof Plan	1.6	G	DO												
			SD-03 Product Data															
			PVC Roofing Membrane	3.3.2	G	DO												
			Bonding Adhesive	2.1.2														

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		07 54 19	Flashing	1.5.3														
			Flashing	3.3.2.2														
			Membrane Fasteners and Plates	2.1.5														
			Roof Insulation	2.1.7														
			Pre-Manufactured Accessories	2.1.6														
			Water Cutoffs	3.6.1														
			Information Card	2.1.1	G	RO												
			SD-05 Design Data															
			Wind Uplift Resistance	1.3.2	G	DO												
			SD-07 Certificates															
			Qualification of Manufacturer	1.5.1	G	RO												
			Qualifications of Applicator	1.5.2	G	RO												
			Fire Resistance	1.3.1														
			Minimum Polymer Thickness	2.1.1														
			Minimum Polymer Thickness	2.1.4														
			Sample	1.10	G	RO												
			SD-08 Manufacturer’s Instructions															
			Application Method	3.3														
			Membrane Flashing	2.1.4	G	DO												
			Membrane Flashing	3.4.2	G	DO												
			Perimeter and High Wind Attachment	3.3.5														
			Auxiliary Fasteners	2.1.5.2														
			Pre-Manufactured Accessories	2.1.6														
			Cold Weather	1.8	G	RO												
			SD-11 Closeout Submittals															

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		07 54 19	Warranty	1.10	G	RO													
			Information Card	2.1.1															
			Instructions to Government	3.9															
			Personnel																
		07 60 00	SD-02 Shop Drawings																
			Exposed Sheet Metal	2.2.1															
			Gutters	3.1.14	G	DO													
			Downspouts	3.1.15	G	DO													
			Expansion Joints	3.1.19	G	DO													
			Counterflashing	3.1.10	G	DO													
			Reglets	2.2.8	G	DO													
			Drip Edges	3.1.13															
			Eave Flashing	3.1.16	G	DO													
			Recycled Content	2.1															
			SD-04 Samples																
			Finish Samples	1.4.2	G	DO													
			SD-05 Design Data																
			Wind Uplift Requirements	1.2.2	G	DO													
			SD-07 Certificates																
			Warranty on Finishes	2.2.6.1															
			SD-08 Manufacturer’s Instructions																
			Instructions for Installation	1.4.3															
			Quality Control Plan	3.5															
			SD-10 Operation and Maintenance																
			Data																
			Cleaning and Maintenance	1.4.3															

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		07 61 14.00 20	SD-02 Shop Drawings																
			Roofing	1.2.5	G	DO													
			SD-03 Product Data																
			Roofing Panels	2.1	G	DO													
			Recycled Content for Steel	2.1.1															
			Roofing Product																
			Attachment Clips	2.3															
			Fasteners	2.4.1															
			Sealants	2.4.2															
			Warranty	1.7	G	RO													
			Snow Guards	1.3.4															
			Snow Guards	2.5															
			SD-04 Samples																
			Panel;	2.1	G	RO													
			SD-05 Design Data																
			Design Calculations	1.5	G	DO													
			SD-06 Test Reports																
			Field Inspection	3.6	G	RO													
			Structural Performance	1.3.3															
			Finish	1.6.6															
			SD-07 Certificates																
			Manufacturer's Technical	1.6.3															
			Representative																
			Installer's Qualifications	1.6.4															
			SD-08 Manufacturer’s Instructions																
			Installation	3.3															

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		07 61 14.00 20	SD-11 Closeout Submittals															
			Warranty	1.7														
		07 81 00	SD-03 Product Data															
			Fireproofing Material	3.3	G	DO												
			SD-06 Test Reports															
			Fire Resistance Rating	1.2.2	G	DO												
			Evaluation Reports	1.2.3														
			SD-07 Certificates															
			Installer Qualifications	1.4.1														
			Surface Preparation Report	3.1	G	RO												
			Manufacturer's Inspection Report	3.5.2	G	RO												
		07 84 00	SD-02 Shop Drawings															
			Firestopping System	2.1	G	DO												
			SD-03 Product Data															
			Firestopping Materials	2.2	G	DO												
			SD-06 Test Reports															
			Inspection	3.3	G	RO												
			SD-07 Certificates															
			Inspector Qualifications	1.5.2														
			Firestopping Materials	2.2														
			Installer Qualifications	1.5.1	G	RO												
		07 92 00	SD-03 Product Data															
			Sealants	2.1														
			Primers	2.2														
			Bond Breakers	2.3														
			Backstops	2.4														

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		07 92 00	Caulking	2.5															
			Cleaning Solvents	2.6															
			Field Adhesion	3.1	G	RO													
			SD-07 Certificates																
			Indoor Air Quality For Interior Sealants	2.1.1															
			Indoor Air Quality For Interior Floor Joint Sealants	2.1.3															
			Indoor Air Quality For Interior Acoustical Sealants	2.1.4															
			Indoor Air Quality For Interior Caulking	2.5															
		08 11 13	SD-02 Shop Drawings																
			Doors	2.1	G	DO													
			Doors	2.1	G	DO													
			Frames	2.5	G	DO													
			Frames	2.5	G	DO													
			Accessories	2.3															
			SD-03 Product Data																
			Doors	2.1	G	DO													
			Frames	2.5	G	DO													
			Accessories	2.3															
		08 33 23	SD-02 Shop Drawings																
			Installation Drawings	2.1.1.1															
			SD-03 Product Data																
			Overhead Coiling Doors	2.2.1	G	DO													

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		08 33 23	Counterbalancing Mechanism	2.2.3	G	DO												
			Electric Door Operators	2.2.4	G	DO												
			Fire-Rated Door Assembly	1.3	G	DO												
			Fire-Rated Door Assembly	2.2.5	G	DO												
			Recycled content for steel curtain slats	2.2.1.1														
			SD-10 Operation and Maintenance Data															
			Operation and Maintenance Manuals	1.3.2	G	RO												
			SD-11 Closeout Submittals															
			Warranty	1.3.1	G	RO												
		08 51 13	SD-03 Product Data															
			Windows	2.1	G	DO												
			Recycled Content of Aluminum Windows	2.1														
			Window Performance	1.7	G	DO												
			Accessories	2.2.5														
			SD-04 Samples															
			Finish Sample	1.3.2.1	G	DO												
		08 51 23	SD-03 Product Data															
			Window	2.2	G	DO												
			Recycled Content for Steel Framing Materials	2.1.1														
			SD-04 Samples															
			Color Coating	2.5.2	G	DO												

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		08 71 00	SD-02 Shop Drawings															
			Hardware Schedule	1.4	G	DO												
			Keying System	2.3.6	G	RO												
			SD-03 Product Data															
			Hardware Items	2.3	G	DO												
			SD-08 Manufacturer’s Instructions															
			Installation	3.1														
			SD-10 Operation and Maintenance															
			Data															
			Hardware Schedule	1.4														
			SD-11 Closeout Submittals															
			Key Bitting	1.5.1														
		08 81 00	SD-03 Product Data															
			Insulating Glass	2.2	G	DO												
			Glazing Accessories	1.3														
			Sealants	2.3.2.1														
			SD-08 Manufacturer’s Instructions															
			Setting and Sealing Materials	2.3														
			Glass Setting	3.2														
			SD-11 Closeout Submittals															
			Insulated Glass Units	1.6.1														
		08 91 00	SD-02 Shop Drawings															
			Wall Louvers	1.4	G	DO												
			SD-03 Product Data															
			Metal Wall Louvers	2.2	G	DO												
			SD-04 Samples															

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		08 91 00	Wall Louver Color Samples	1.5	G	DO													
		09 22 00	SD-02 Shop Drawings																
			Metal Support Systems	2.1															
			SD-03 Product Data																
			Metal Support Systems	2.1															
			Recycled Content for Metal	2.1															
			Support Systems																
		09 29 00	SD-03 Product Data																
			Cementitious Backer Units	2.1.5															
			Glass Mat Water-Resistant	2.1.4															
			Gypsum Tile Backing Board																
			Water-Resistant Gypsum Backing	2.1.3															
			Board																
			Glass Mat Covered or Reinforced																
			Gypsum Sheathing																
			Glass Mat Covered or Reinforced																
			Gypsum Sheathing Sealant																
			Accessories	2.1.9															
			Gypsum Board	2.1.1															
			Recycled Content for Gypsum	2.1.1															
			Board																
			Recycled Content for Paper	2.1.1															
			Facing and Gypsum Cores																
			VOC Content of Joint Compound	2.1.6															
			SD-06 Test Reports																
			ASTM E90 Factory Test Report	3.7															

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		09 29 00	SD-07 Certificates															
			Asbestos Free Materials	2.1	G	RO												
			Indoor Air Quality for Gypsum	2.1.1														
			Board															
			Indoor Air Quality for Non-aerosol	2.1.8														
			Adhesives															
			Indoor Air Quality for Aerosol	2.1.8														
			Adhesives															
		09 30 10	SD-03 Product Data															
			Porcelain Tile	2.1.1	G	DO												
			Transition Strips	2.1														
			Transition Strips	2.5.1														
			Metal Strips	2.5.2														
			Setting-Bed	2.2														
			Mortar, Grout, and Adhesive	2.4														
			Crack Isolation Membrane	2.6														
			SD-04 Samples															
			Tile	2.1	G	DO												
			Transition Strips	2.1														
			Transition Strips	2.5.1														
			Metal Strips	2.5.2														
			Grout	2.4.4														
			SD-07 Certificates															
			Water Absorption Rates	1.3.1														
			SD-10 Operation and Maintenance															
			Data															

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		09 30 10	Porcelain Tile	2.1.1	G	RO													
		09 51 00	SD-03 Product Data																
			Acoustical Ceiling Systems	2.2															
			Recycled Content for Type III	2.2.1.1															
			Ceiling Tiles																
			Recycled Content for Suspension	2.3															
			Systems																
			SD-07 Certificates																
			Indoor Air Quality for Type III	2.2.1.1															
			Ceiling Tiles																
		09 65 00	SD-02 Shop Drawings																
			Resilient Flooring and	2.8															
			Accessories																
			SD-03 Product Data																
			Resilient Flooring and	2.8	G	DO													
			Accessories																
			Adhesives	2.4															
			SD-04 Samples																
			Resilient Flooring and	2.8	G	DO													
			Accessories																
			SD-06 Test Reports																
			Moisture, Alkalinity and Bond	3.3	G	RO													
			Tests																
			SD-08 Manufacturer’s Instructions																
			Surface Preparation	3.2															
			Installation	3.1															

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		09 65 00	SD-10 Operation and Maintenance																
			Data																
			Resilient Flooring and	2.8	G	RO													
			Accessories																
		09 90 00	SD-02 Shop Drawings																
			Piping Identification	3.7															
			SD-03 Product Data																
			Coating	2.1	G	DO													
			Product Data Sheets	2.1															
			SD-04 Samples																
			Color	2.2	G	DO													
			SD-07 Certificates																
			Indoor Air Quality for Paints and	1.5.3															
			Primers																
			SD-08 Manufacturer’s Instructions																
			Application Instructions	2.1															
			Mixing	2.1															
			Manufacturer's Safety Data	1.7.1															
			Sheets																
		09 97 13.27	SD-01 Preconstruction Submittals																
			Contract Errors, Omissions, and	1.4.1															
			Other Discrepancies																
			Corrective Action Procedures	1.4.2.1															
			Corrective Action Request (CAR)	1.4.2.2															
			Form																
			Coatings Work Plan	1.4.3															

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		09 97 13.27	Inspection Report Forms	3.7.1.2															
			SD-05 Design Data																
			Containment System	1.4.4.1															
			SD-06 Test Reports																
			Coatings Qualification Test	1.4.5.1															
			Reports																
			Ferrous Metallic Abrasive	1.4.5.2															
			Qualification Test Reports																
			Non-Metallic Abrasive	1.4.5.3															
			Qualification Test Reports																
			Coating Field Test Reports	3.1.3															
			Abrasive Field Test Reports	3.1.4															
			Recycled Ferrous Metallic	1.4.5.4															
			Abrasive Field Test Reports (Daily																
			and Weekly)																
			Daily Inspection Reports	3.7.1.3															
			SD-07 Certificates																
			Qualifications of Certified	1.4.6.1															
			Industrial Hygienist (CIH)																
			Qualifications of Protective	1.4.6.2															
			Coatings Specialist (PCS)																
			Qualifications of Coatings	1.4.6.3															
			Inspection Company																
			Qualifications of Quality	1.4.6.4															
			Assurance Coatings Inspector																

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		09 97 13.27	Qualifications of Coatings	1.4.6.5															
			Contractor Company																
			Qualifications of Individuals	1.4.6.6															
			Performing Abrasive Blasting																
			Qualifications of Individuals	1.4.6.7															
			Applying Coatings																
			Qualifications of Testing	1.4.6.8															
			Laboratory for Coatings																
			Qualifications of Testing	1.4.6.9															
			Laboratory for Abrasive																
			Coating Materials Certificate of	1.4.6.10															
			Conformance																
			Non-Metallic Abrasive Certificate	1.4.6.12															
			of Conformance																
			Ferrous Metallic Abrasive	1.4.6.11															
			Certificate of Conformance																
			SD-08 Manufacturer’s Instructions																
			Coating System Instructions	1.5.1															
			SD-11 Closeout Submittals																
			Disposal of Used Abrasive	3.5.6															
			Inspection Logbook	3.7.1.4	G	RO													
			Corrective Action Log	1.4.2.3	G	RO													
		10 14 00.10	SD-02 Shop Drawings																
			Approved Detail Drawings	3.1	G	RO													
			SD-03 Product Data																
			Modular Exterior Signage System	2.1															

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		10 14 00.10	Installation	3.1															
			Exterior Signage	1.2	G	RO													
			SD-04 Samples																
			Exterior Signage	1.2	G	RO													
			SD-10 Operation and Maintenance																
			Data																
			Protection and Cleaning	3.1.2															
		10 14 00.20	SD-02 Shop Drawings																
			Detail Drawings	1.3.2	G	DO													
			SD-03 Product Data																
			Room Identification Signage	2.1	G	DO													
			System																
			Exit Door Tactile Sign	2.2	G	DO													
			Door Tags	2.3	G	RO													
			SD-04 Samples																
			Interior Signage	1.3.1	G	DO													
			Room Identification Signage	2.1	G	DO													
			System																
			Exit Door Tactile Sign	2.2	G	DO													
			Door Tags	2.3	G	RO													
			SD-10 Operation and Maintenance																
			Data																
			Approved Manufacturer's	3.2	G	RO													
			Instructions																
			Protection and Cleaning	3.2.2	G	RO													
		10 22 13	SD-02 Shop Drawings																

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		10 22 13	Wire Mesh Partitions	1.4	G	RO												
			SD-03 Product Data															
			Wire Mesh Partitions	1.4	G	DO												
		10 28 13	SD-03 Product Data															
			Item A5083	2.1.3	G	RO												
			Item A5109	2.1.4	G	RO												
			Item A5135	2.1.5	G	RO												
			Item A5145	2.1.6	G	RO												
			Item A5195	2.1.7	G	RO												
		10 44 16	SD-02 Shop Drawings															
			Accessories	Part 2														
			Wall Brackets	2.2.1	G	RO												
			SD-03 Product Data															
			Accessories	Part 2														
			Wall Brackets	2.2.1														
			Replacement Parts List	3.2.1														
		11 11 37	SD-02 Shop Drawings															
			Cords	2.2.3	G	DO												
			Level 2 Wall Mounted EVSE	2.2.2.1	G	DO												
			SD-03 Product Data															
			Cords	2.2.3	G	DO												
			Level 2 Wall Mounted EVSE	2.2.2.1	G	DO												
			SD-07 Certificates															
			Qualifications	1.6.2.1														
			Certified Installers	1.2.2														
			SD-08 Manufacturer’s Instructions															

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		11 11 37	Cords	2.2.3	G	DO												
			Level 2 Wall Mounted EVSE	2.2.2.1	G	DO												
			SD-09 Manufacturer's Field															
			Reports															
			Testing of Electric Vehicle Supply	3.8.1														
			Equipment															
			SD-10 Operation and Maintenance															
			Data															
			Electric Vehicle Supply	2.2														
			Equipment															
			SD-11 Closeout Submittals															
			Warranty	1.7	G	RO												
			Record Documentation	3.7	G	RO												
		12 21 00	SD-02 Shop Drawings															
			Installation	3.3														
			SD-03 Product Data															
			Window Blinds	2.1	G	DO												
			SD-04 Samples															
			Window Blinds	2.1	G	DO												
			SD-06 Test Reports															
			Window Blinds	2.1														
			SD-08 Manufacturer's Instructions															
			Window Blinds	2.1	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Window Blinds	2.1	G	RO												

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		13 48 73	SD-02 Shop Drawings																
			Bracing	3.1	G	DO													
			Resilient Vibration Isolation	3.4															
			Devices																
			Equipment Requirements	2.1															
			SD-03 Product Data																
			Bracing	3.1															
			Equipment Requirements	2.1															
			Anchor Bolts	3.3															
			Vibration Isolators	2.1.2	G	DO													
			Snubbers	3.4.2															
			SD-05 Design Data																
			Design Calculations	1.2.3	G	DO													
			SD-06 Test Reports																
			Anchor Bolts	3.3															
			SD-07 Certificates																
			ICC ES AC156 Shake Table Test	3.6	G	DO													
		21 13 13	SD-01 Preconstruction Submittals																
			Sprinkler System Designer	1.4.2.1	G	DO													
			Sprinkler System Installer	1.4.2.2	G	DO													
			SD-02 Shop Drawings																
			Shop Drawing	1.2.1.1	G	DO													
			SD-03 Product Data																
			Pipe	2.2.1	G	DO													
			Fittings	2.3.1.2	G	DO													
			Valves	2.3.4	G	DO													

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		21 13 13	Relief Valves	2.8.5	G	DO												
			Sprinklers	2.7	G	DO												
			Pipe Hangers and Supports	2.3.3	G	DO												
			Sprinkler Alarm Switch	2.4.1	G	DO												
			Valve Supervisory (Tamper)	2.4.2	G	DO												
			Switch															
			Fire Department Connection	2.6	G	DO												
			Backflow Prevention Assembly	2.5	G	DO												
			Air Vent	2.8.6	G	DO												
			Hose Valve	2.5.1	G	DO												
			Seismic Bracing	2.3.3	G	DO												
			Nameplates	2.1.2	G	RO												
			SD-05 Design Data															
			Seismic Bracing	2.3.3	G	DO												
			Hydraulic Calculations	1.2.1.2	G	DO												
			SD-06 Test Reports															
			Test Procedures	3.7.1	G	RO												
			SD-07 Certificates															
			Verification of Compliant	3.7.2.1	G	RO												
			Installation															
			Request for Government Final	3.7.2.2	G	RO												
			Test															
			SD-10 Operation and Maintenance															
			Data															
			Operating and Maintenance	3.9	G	RO												
			(O&M) Instructions															

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		21 13 13	Spare Parts	1.6	G	RO													
			SD-11 Closeout Submittals																
			As-built drawings	3.9															
		21 13 18	SD-01 Preconstruction Submittals																
			Sprinkler System Designer	1.5.2.1	G	DO													
			Sprinkler System Installer	1.5.2.2	G	DO													
			Releasing System Designer	1.5.2.3	G	DO													
			Releasing System Technician	1.5.2.4	G	DO													
			Releasing System Installer	1.5.2.5	G	DO													
			Nitrogen Generation System	1.5.2.6	G	DO													
			Commissioning Technician																
			Releasing System Site-Specific	1.4	G	DO													
			Software Acknowledgement																
			SD-02 Shop Drawings																
			Shop Drawing	1.2.1.1	G	DO													
			Wiring Diagrams	1.5.1.2	G	DO													
			Control System Layout	1.5.1.3	G	DO													
			Battery Power (RSCP)	2.20.1.2	G	DO													
			Voltage Drop Calculations	2.20.1.2	G	DO													
			(RSCP)																
			SD-03 Product Data																
			Pipe	2.2.1	G	DO													
			Fittings	2.3.1.2	G	DO													
			Valves	2.3.3	G	DO													
			Relief Valves	2.10.5	G	DO													
			Sprinklers	2.9	G	DO													

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		21 13 18	Pipe Hangers and Supports	2.3.2	G	DO												
			Sprinkler Alarm Switch	2.6.1	G	DO												
			Valve Supervisory (Tamper)	2.6.3	G	DO												
			Switch															
			Fire Department Connection	2.8	G	DO												
			Backflow Prevention Assembly	2.7	G	DO												
			Hose Valve	2.7.1	G	DO												
			Seismic Bracing	2.3.2	G	DO												
			High/Low-Nitrogen Pressure	2.6.2	G	DO												
			Supervisory Switch															
			Pre-Action Valve	2.4	G	DO												
			Nitrogen Generation System	1.5.2.6	G	DO												
			Releasing Service Fire Alarm	2.11	G	DO												
			Control Panel (RSCP)															
			Terminal Cabinets	3.5.3.2	G	DO												
			Auxiliary Power Supply Panels	2.20.1.1	G	DO												
			Nameplates	2.1.2	G	RO												
			Batteries (RSCP)	2.20.1	G	DO												
			Battery Chargers	2.20.2	G	DO												
			Heat Detectors	2.13	G	DO												
			Addressable Interface Devices	2.14	G	DO												
			(RSCP)															
			Addressable Control Modules	2.15	G	DO												
			(RSCP)															
			Isolation Modules	2.16	G	DO												
			Surge Protective Devices	2.18	G	DO												

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		21 13 18	SD-05 Design Data															
			Seismic Bracing	2.3.2	G	DO												
			Hydraulic Calculations	1.2.1.2	G	DO												
			Voltage Drop Calculations (RSCP)	2.20.1.2	G	DO												
			SD-06 Test Reports															
			Test Procedures	3.8.1	G	RO												
			SD-07 Certificates															
			Verification of Compliant Installation	3.8.2.1	G	RO												
			Request for Government Final Test	3.8.2.2	G	RO												
			SD-10 Operation and Maintenance Data															
			Operating and Maintenance (O&M) Instructions	3.10	G	RO												
			Spare Parts	1.7	G	RO												
			SD-11 Closeout Submittals															
			As-built drawings	3.10														
			Document Storage Cabinet	3.12.3	G	RO												
			Initiating Devices	3.8.1	G	RO												
		21 30 00	SD-01 Preconstruction Submittals															
			Fire Pump Installation Related Submittals	1.3														
			Fire Protection Specialist	1.7.1	G	DO												
			SD-02 Shop Drawings															

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		21 30 00	Installation Drawings	3.3.1	G	DO													
			As-Built Drawings	3.11.2	G	RO													
			Piping Layout	3.3.2	G	DO													
			Pump Room	3.3.2	G	DO													
			SD-03 Product Data																
			Catalog Data	2.1	G	DO													
			Spare Parts	1.6															
			Preliminary Tests	3.8.2															
			Field Tests	3.8	G	RO													
			Manufacturer's Representative	1.7.6	G	RO													
			Field Training	3.11.1	G	RO													
			SD-06 Test Reports																
			Preliminary Tests	3.8.2															
			SD-07 Certificates																
			Fire Protection Specialist	1.7.1															
			Qualifications of Welders	1.7.2															
			Qualifications of Installer	1.7.3															
			Preliminary Test Certification	1.7.4															
			Final Test Certification	1.7.5															
			SD-10 Operation and Maintenance																
			Data																
			Operating and Maintenance	3.11.1	G	RO													
			Instructions																
			Flow Meter	2.17															
		22 00 00	SD-02 Shop Drawings																
			Plumbing System	3.8.1	G	RO													

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		22 00 00	SD-03 Product Data															
			WATER HEATERS	2.8	G	DO												
			PUMPS	2.10	G	DO												
			Backflow Prevention Assemblies	3.8.1.1	G	RO												
			WaterSense Label for Lavatory	2.4.2														
			Faucet															
			Fixtures	2.4														
			Flush Valve Water Closets	2.4.1														
			WaterSense Label for Flush	2.4.1														
			Valve Water Closet															
			Wall Hung Lavatories	2.4.2														
			Service Sinks	2.4.3														
			Welding	1.5.1	G	RO												
			Plumbing System	3.8.1														
			SD-06 Test Reports															
			Tests, Flushing and Disinfection	3.8	G	RO												
			Test of Backflow Prevention	3.8.1.1	G	RO												
			Assemblies															
			SD-07 Certificates															
			Materials and Equipment	1.3														
			Bolts	2.1.1														
			SD-10 Operation and Maintenance															
			Data															
			Plumbing System	3.8.1	G	RO												
		23 05 48.19	SD-02 Shop Drawings															
			Coupling and Bracing	3.1														

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		23 05 48.19	Flexible Couplings or Joints	3.3															
			Equipment Restraint	2.2															
			Contractor Designed Bracing	1.2.4	G	DO													
			SD-03 Product Data																
			Coupling and Bracing	3.1	G	DO													
			Flexible Couplings Or Joints	3.3															
			Equipment Restraint	2.2	G	DO													
			Contractor Designed Bracing	1.2.4	G	DO													
			Snubbers	2.6															
			Anchor Bolts	3.9															
			Vibration Isolators	2.2.2															
			SD-05 Design Data																
			Design Calculations	1.2.4															
			SD-06 Test Reports																
			Anchor Bolts	3.9	G	DO													
		23 05 93	SD-02 Shop Drawings																
			TAB Schematic Drawings and	1.3.2	G	RO													
			Report Forms																
			SD-03 Product Data																
			Equipment and Performance	1.3	G	RO													
			Data																
			TAB Related HVAC Submittals	3.2	G	RO													
			TAB Related HVAC Submittals	3.2	G	RO													
			SD-07 Certificates																
			Independent TAB Agency and	1.5.1	G	RO													
			Personnel Qualifications																

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		23 05 93	TAB Submittal and Work	3.2	G	RO												
			Schedule															
			TAB Pre-Field Engineering	3.3.2	G	RO												
			Report															
		23 07 00	SD-02 Shop Drawings															
			MICA Plates	3.2.2.4	G	RO												
			Pipe Insulation Systems	2.3														
			Pipe Insulation Systems	3.2														
			Duct Insulation Systems	3.3														
			SD-03 Product Data															
			Pipe Insulation Systems	2.3	G	RO												
			Pipe Insulation Systems	3.2	G	RO												
			Duct Insulation Systems	3.3	G	RO												
			SD-04 Samples															
			Thermal Insulation	2.2.1.2	G	RO												
			Display Samples	3.1.1	G	RO												
			SD-08 Manufacturer’s Instructions															
			Pipe Insulation Systems	2.3	G	RO												
			Pipe Insulation Systems	3.2	G	RO												
			Duct Insulation Systems	3.3	G	RO												
		23 08 00	SD-03 Product Data															
			Test Equipment	2.1														
			SD-06 Test Reports															
			Pipe Flushing, Testing, And	1.5	G	RO												
			Water Treatment Reports															

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		23 08 00	Completed Pre-Functional	3.3	G	RO												
			Checklists															
			Post-Construction Trend Log	3.13	G	RO												
			Report															
			SD-07 Certificates															
			Certificate Of Readiness	1.6	G	RO												
		23 09 00	SD-02 Shop Drawings															
			DDC Contractor Design Drawings	3.2	G	DO												
			Draft As-Built Drawings	3.2	G	RO												
			Final As-Built Drawings	3.2	G	RO												
			SD-03 Product Data															
			Programming Software	1.8.3	G	RO												
			Controller Application Programs	1.8.4	G	RO												
			Configuration Software	1.8.1	G	RO												
			Controller Configuration Settings	1.8.2	G	RO												
			Manufacturer's Product Data	2.2	G	RO												
			Niagara Framework Supervisory	1.8.5	G	RO												
			Gateway Backups															
			Niagara Framework Engineering	1.5	G	RO												
			Tool															
			Niagara Framework Engineering	1.8.6	G	RO												
			Tool															
			Niagara Framework Wizards	1.5	G	RO												
			SD-06 Test Reports															
			Pre-Construction Quality Control	1.9.1	G	RO												
			(QC) Checklist															

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		23 09 00	Post-Construction Quality Control	1.9.2	G	RO												
			(QC) Checklist															
			Start-Up Testing Report	3.4.2	G	RO												
			PVT Procedures	3.5.1	G	RO												
			PVT Report	3.5.3	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	3.6	G	RO												
			(O&M) Instructions															
			Training Documentation	3.7.1	G	RO												
			SD-11 Closeout Submittals															
			Enclosure Keys	2.5	G	RO												
			Password Summary Report	3.1.6.1	G	RO												
			Closeout Quality Control (QC)	1.9.3	G	RO												
			Checklist															
		23 23 00	SD-02 Shop Drawings															
			Refrigerant Piping System	2.3														
			SD-03 Product Data															
			Refrigerant Piping System	2.3														
			Spare Parts	1.5.2														
			Refrigerant Piping Tests	3.5														
			Verification of Dimensions	3.1														
			SD-06 Test Reports															
			Refrigerant Piping Tests	3.5														
			SD-07 Certificates															
			Service Organization	2.1														

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		23 23 00	SD-10 Operation and Maintenance																
			Data																
			Maintenance	1.5	G	RO													
			Operation and Maintenance	3.4	G	RO													
			Manuals																
			Demonstrations	3.4	G	RO													
		23 30 00	SD-02 Shop Drawings																
			Detail Drawings	1.4.4	G	DO													
			SD-03 Product Data																
			Insulated Nonmetallic Flexible	2.8.1.1															
			Duct Runouts																
			Duct Connectors	2.8.1.1															
			Duct Access Doors	2.8.2															
			Manual Balancing Dampers	2.8.3															
			Diffusers	2.8.6.1															
			Registers and Grilles	2.8.6.2															
			Louvers	2.8.7															
			Air Vents, Penthouses, and	2.8.8															
			Goosenecks																
			In-Line Centrifugal Fans	2.9.1.1															
			Axial Flow Fans	2.9.1.2	G	DO													
			Ceiling Exhaust Fans	2.9.1.3															
			Test Procedures	1.4.5															
			Diagrams	1.2.1.2	G	RO													
			SD-06 Test Reports																
			Performance Tests	3.9	G	RO													

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ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH #	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
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		23 30 00	SD-07 Certificates																
			Bolts	1.4.1															
			Ozone Depleting Substances	1.4.3															
			Technician Certification																
			SD-08 Manufacturer’s Instructions																
			Manufacturer's Installation	3.2															
			Instructions																
			Operation and Maintenance	3.11.2															
			Training																
			SD-10 Operation and Maintenance																
			Data																
			Operation and Maintenance	3.11.1	G	RO													
			Manuals																
			Manual Balancing Dampers	2.8.3															
			In-Line Centrifugal Fans	2.9.1.1															
			Axial Flow Fans	2.9.1.2	G	RO													
			Ceiling Exhaust Fans	2.9.1.3															
		23 81 00	SD-03 Product Data																
			Spare Parts	3.7.1															
			Posted Instructions	3.4															
			System Performance Tests	3.6															
			Training	3.4															
			Inventory	1.4															
			Supplied Products	2.1	G	DO													
			Manufacturer's Standard Catalog	2.2															
			Data																

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		23 81 00	SD-06 Test Reports																
			Refrigerant Tests, Charging, and	3.5															
			Start-Up																
			System Performance Tests	3.6	G	RO													
			SD-07 Certificates																
			Service Organizations	3.7.2															
			SD-10 Operation and Maintenance																
			Data																
			Operation and Maintenance	3.4	G	RO													
			Manuals																
			SD-11 Closeout Submittals																
			Ozone Depleting Substances	2.2.2.3															
		23 82 46.00 40	SD-02 Shop Drawings																
			Fabrication Drawings	1.2.1															
			SD-03 Product Data																
			Performance Data	2.1	G	DO													
			Electric Unit Heaters	2.1	G	DO													
			Heating Element	2.2.1															
			Controls	2.2.2	G	DO													
			Casings	3.1.1															
			Propellers and Motors	2.2.3	G	DO													
			SD-08 Manufacturer’s Instructions																
			Manufacturer's Instructions	1.2.1	G	RO													
		25 05 11.01	SD-01 Preconstruction Submittals																
			Device Account Lock Exception	3.3.2	G	HNC													
			Request																

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		25 05 11.01	Multiple Ethernet Connection	3.2.4.2	G	HNC													
			Device Request																
			Contractor Computer	1.10.1.6	G	HNC													
			Cybersecurity Compliance																
			Statements																
			Contractor Temporary Network	1.10.6	G	HNC													
			Cybersecurity Compliance																
			Statements																
			Cybersecurity Interconnection	1.8.2	G	HNC													
			Schedule																
			Proposed STIG and SRG	1.8.1	G	HNC													
			Applicability Report																
			Resumes and Certifications	1.7.1	G	HNC													
			SD-02 Shop Drawings																
			Network Communication Report	1.8.3	G	HNC													
			Cybersecurity Riser Diagram	1.8.6	G	HNC													
			SD-03 Product Data																
			Control System Cybersecurity	1.8.8	G	HNC													
			Documentation																
			SD-06 Test Reports																
			Control System Cybersecurity	3.14.1	G	HNC													
			Testing Procedures																
			Control System Cybersecurity	3.14.3	G	HNC													
			Testing Report																
			SD-07 Certificates																
			Software Licenses	1.9	G	HNC													

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		25 05 11.01	SD-11 Closeout Submittals															
			Confidential Password Report	3.4.5.4	G	RO												
			Enclosure Keys	3.3.7	G	RO												
			Software and Configuration	1.8.5	G	HNC												
			Backups															
			Auditing Front End Software	3.5.3	G	HNC												
			Device Audit Record Upload	3.5.4.1	G	HNC												
			Software															
			System Maintenance Tool	3.9	G	HNC												
			Software															
			Control System Scanning Tools	3.11.1	G	HNC												
			STIG, SRG and Vendor Guide	1.8.7	G	HNC												
			Compliance Result Report															
			Control System Inventory Report	1.8.4	G	HNC												
			Integrity Verification Software	3.13.1	G	HNC												
		25 05 11.02	SD-01 Preconstruction Submittals															
			Device Account Lock Exception	3.3.2	G	HNC												
			Request															
			Multiple Ethernet Connection	3.2.4.2	G	HNC												
			Device Request															
			Contractor Computer	1.10.1.6	G	HNC												
			Cybersecurity Compliance															
			Statements															
			Contractor Temporary Network	1.10.6	G	HNC												
			Cybersecurity Compliance															
			Statements															

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		25 05 11.02	Cybersecurity Interconnection	1.8.2	G	HNC													
			Schedule																
			Proposed STIG and SRG	1.8.1	G	HNC													
			Applicability Report																
			Resumes and Certifications	1.7.1	G	HNC													
			SD-02 Shop Drawings																
			Network Communication Report	1.8.3	G	HNC													
			Cybersecurity Riser Diagram	1.8.6	G	HNC													
			SD-03 Product Data																
			Control System Cybersecurity	1.8.8	G	HNC													
			Documentation																
			SD-06 Test Reports																
			Control System Cybersecurity	3.14.1	G	HNC													
			Testing Procedures																
			Control System Cybersecurity	3.14.3	G	HNC													
			Testing Report																
			SD-07 Certificates																
			Software Licenses	1.9	G	HNC													
			SD-11 Closeout Submittals																
			Confidential Password Report	3.4.5.4	G	RO													
			Enclosure Keys	3.3.7	G	RO													
			Software and Configuration	1.8.5	G	HNC													
			Backups																
			Auditing Front End Software	3.5.3	G	HNC													
			Device Audit Record Upload	3.5.4.1	G	HNC													
			Software																

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		25 05 11.02	System Maintenance Tool	3.9	G	HNC													
			Software																
			Control System Scanning Tools	3.11.1	G	HNC													
			STIG, SRG and Vendor Guide	1.8.7	G	HNC													
			Compliance Result Report																
			Control System Inventory Report	1.8.4	G	HNC													
			Integrity Verification Software	3.13.1	G	HNC													
		25 05 11.03	SD-01 Preconstruction Submittals																
			Device Account Lock Exception	3.3.2	G	HNC													
			Request																
			Multiple Ethernet Connection	3.2.3.2	G	HNC													
			Device Request																
			Contractor Computer	1.10.1.6	G	HNC													
			Cybersecurity Compliance																
			Statements																
			Contractor Temporary Network	1.10.6	G	HNC													
			Cybersecurity Compliance																
			Statements																
			Resumes and Certifications	1.7.1	G	HNC													
			SD-02 Shop Drawings																
			Network Communication Report	1.8.1	G	HNC													
			Cybersecurity Riser Diagram	1.8.4	G	HNC													
			SD-03 Product Data																
			Control System Cybersecurity	1.8.6	G	HNC													
			Documentation																
			SD-06 Test Reports																

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		25 05 11.03	Control System Cybersecurity Testing Procedures	3.13.1	G	HNC												
			Control System Cybersecurity Testing Report	3.13.3	G	HNC												
			SD-07 Certificates															
			Software Licenses	1.9	G	HNC												
			SD-11 Closeout Submittals															
			Confidential Password Report	3.4.5.3	G	RO												
			Enclosure Keys	3.3.7	G	RO												
			Software and Configuration Backups	1.8.3	G	HNC												
			Auditing Front End Software	3.5.3	G	HNC												
			Device Audit Record Upload Software	3.5.4.1	G	HNC												
			System Maintenance Tool Software	3.8	G	HNC												
			Control System Scanning Tools	3.10.1	G	HNC												
			Vendor Guide Compliance Result Report	1.8.5	G	HNC												
			Control System Inventory Report	1.8.2	G	HNC												
			Integrity Verification Software	3.12.1	G	HNC												
		25 05 11.04	SD-01 Preconstruction Submittals															
			Device Account Lock Exception Request	3.3.2	G	HNC												
			Multiple Ethernet Connection Device Request	3.2.4.2	G	HNC												

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		25 05 11.04	Contractor Computer	1.10.1.6	G	HNC													
			Cybersecurity Compliance																
			Statements																
			Contractor Temporary Network	1.10.6	G	HNC													
			Cybersecurity Compliance																
			Statements																
			Proposed STIG and SRG	1.8.1	G	HNC													
			Applicability Report																
			Resumes and Certifications	1.7.1	G	HNC													
			SD-02 Shop Drawings																
			Network Communication Report	1.8.2	G	HNC													
			Cybersecurity Riser Diagram	1.8.5	G	HNC													
			SD-03 Product Data																
			Control System Cybersecurity	1.8.7	G	HNC													
			Documentation																
			SD-06 Test Reports																
			Control System Cybersecurity	3.14.1	G	HNC													
			Testing Procedures																
			Control System Cybersecurity	3.14.3	G	HNC													
			Testing Report																
			SD-07 Certificates																
			Software Licenses	1.9	G	HNC													
			SD-11 Closeout Submittals																
			Confidential Password Report	3.4.5.4	G	RO													
			Enclosure Keys	3.3.7	G	RO													

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		25 05 11.04	Software and Configuration	1.8.4	G	HNC												
			Backups															
			Auditing Front End Software	3.5.3	G	HNC												
			Device Audit Record Upload	3.5.4.1	G	HNC												
			Software															
			System Maintenance Tool	3.9	G	HNC												
			Software															
			Control System Scanning Tools	3.11.1	G	HNC												
			STIG, SRG and Vendor Guide	1.8.6	G	HNC												
			Compliance Result Report															
			Control System Inventory Report	1.8.3	G	HNC												
			Integrity Verification Software	3.13.1	G	HNC												
		25 05 11.05	SD-01 Preconstruction Submittals															
			Device Account Lock Exception	3.3.2	G	HNC												
			Request															
			Multiple Ethernet Connection	3.2.4.2	G	HNC												
			Device Request															
			Contractor Computer	1.10.1.6	G	HNC												
			Cybersecurity Compliance															
			Statements															
			Contractor Temporary Network	1.10.6	G	HNC												
			Cybersecurity Compliance															
			Statements															
			Cybersecurity Interconnection	1.8.2	G	HNC												
			Schedule															

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		25 05 11.05	Proposed STIG and SRG	1.8.1	G	HNC													
			Applicability Report																
			Resumes and Certifications	1.7.1	G	HNC													
			SD-02 Shop Drawings																
			Network Communication Report	1.8.3	G	HNC													
			Cybersecurity Riser Diagram	1.8.6	G	HNC													
			SD-03 Product Data																
			Control System Cybersecurity	1.8.8	G	HNC													
			Documentation																
			SD-06 Test Reports																
			Control System Cybersecurity	3.14.1	G	HNC													
			Testing Procedures																
			Control System Cybersecurity	3.14.3	G	HNC													
			Testing Report																
			SD-07 Certificates																
			Software Licenses	1.9	G	HNC													
			SD-11 Closeout Submittals																
			Confidential Password Report	3.4.5.5	G	RO													
			Enclosure Keys	3.3.7	G	RO													
			Software and Configuration	1.8.5	G	HNC													
			Backups																
			Auditing Front End Software	3.5.3	G	HNC													
			Device Audit Record Upload	3.5.4.2	G	HNC													
			Software																
			System Maintenance Tool	3.9	G	HNC													
			Software																

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		25 05 11.05	Control System Scanning Tools	3.11.2	G	HNC													
			STIG, SRG and Vendor Guide	1.8.7	G	HNC													
			Compliance Result Report																
			Control System Inventory Report	1.8.4	G	HNC													
			Integrity Verification Software	3.13.2	G	HNC													
		25 08 10	SD-06 Test Reports																
			PVT Plan	3.1.1	G	RO													
			PVT Phase I Report	3.1.2.1	G	RO													
			PVT Phase II Report	3.1.2.2	G	RO													
			SD-07 Certificates																
			Test Instrumentation Calibration	1.4	G	RO													
			Certificates																
		26 05 48	SD-02 Shop Drawings																
			Equipment Requirements	2.1	G	DO													
			Lighting Fixtures	3.4	G	DO													
			SD-03 Product Data																
			Supports and Attachments	1.2.3	G	DO													
			Equipment Requirements	2.1	G	DO													
			Lighting Fixtures	3.4	G	DO													
			Flexible Fittings	2.4	G	DO													
			Anchors	3.5	G	DO													
			Isolation And Energy Dissipation	2.1	G	DO													
			Systems																
			SD-05 Design Data																
			Design Calculations	1.2.3	G	DO													
			Design Drawings	1.2.3	G	DO													

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		26 05 48	Independent Design Review	1.2.3	G	DO												
			Report															
			SD-06 Test Reports															
			Anchors	3.5	G	RO												
			SD-07 Certificates															
			ICC ES AC156 Shake Table Test	3.7	G	RO												
		26 05 73	SD-01 Preconstruction Submittals															
			Field Examination Plan	3.1	G	RO												
			Arc Flash Label Formats	3.2.4	G	RO												
			SD-03 Product Data															
			Determination of Facts	2.3.2	G	DO												
			Documentation of Utility	2.3.2	G	DO												
			Characteristics															
			Interim Load Flow Study	2.1	G	DO												
			Interim Fault Current Analysis	2.1	G	DO												
			Interim Protective Device	2.1	G	DO												
			Coordination Study															
			Load Flow Study	2.3.5	G	DO												
			Fault Current Analysis	2.3	G	DO												
			Protective Device Coordination	2.3	G	DO												
			Study															
			Arc Flash Hazard Analysis	2.3	G	DO												
			Transformer Inrush Data	2.3	G	DO												
			Protective Relay Settings	2.3	G	DO												
			Installation	2.3.2	G	DO												

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		26 05 73	Adjustable-Trip Circuit Breaker	3.1.3	G	DO													
			Circuit Corrections																
			Interim Load Flow Study (Offload)	2.2	G	DO													
			Interim Fault Current Analysis	2.2	G	DO													
			(Offload)																
			Interim Protective Device	2.2	G	DO													
			Coordination Study (Offload)																
			Load Flow Study (Offload)	2.2	G	DO													
			Fault Current Analysis (Offload)	2.2	G	DO													
			Protective Device Coordination	2.2	G	DO													
			Study (Offload)																
			Arc Flash Hazard Analysis	2.2	G	DO													
			(Offload)																
			SD-06 Test Reports																
			Field Examination	3.1	G	RO													
			SD-07 Certificates																
			System Coordinator	1.4.1	G	RO													
			SD-11 Closeout Submittals																
			Model Files	3.3	G	RO													
			Load Flow Study	2.3.5	G	RO													
			Fault Current Study	2.3.6	G	RO													
			System Coordination Study	2.3.7	G	RO													
			Arc Flash Hazard Study	2.3.8	G	RO													
		26 08 00	SD-06 Test Reports																
			Acceptance Tests and	3.1	G	RO													
			Inspections																

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		26 08 00	SD-07 Certificates															
			Qualifications	1.4.1	G	RO												
			Acceptance Test and Inspections	1.4.3	G	RO												
			Procedure															
		26 12 19.10	SD-02 Shop Drawings															
			Pad-mounted Transformer	1.5.1	G	DO												
			Drawings (Fire Pump)															
			Pad-mounted Transformer	1.5.1	G	DO												
			Drawings (Offload)															
			Pad-mounted Transformer	1.5.1	G	DO												
			Drawings (T442)															
			SD-03 Product Data															
			Pad-mounted Transformers (Fire	2.2	G	DO												
			Pump)															
			Pad-mounted Transformer	2.2	G	DO												
			(Offload)															
			Pad-mounted Transformer (T442)	2.2	G	DO												
			SD-06 Test Reports															
			Acceptance Checks and Tests	3.6.1	G	RO												
			SD-07 Certificates															
			Transformer Efficiencies	2.2.2.1	G	RO												
			SD-09 Manufacturer’s Field															
			Reports															
			Transformer Test Schedule	2.8.1	G	RO												
			Design Tests	2.8.2	G	RO												
			Routine and Other Tests	2.8.3	G	RO												

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		26 12 19.10	SD-10 Operation and Maintenance															
			Data															
			Transformer(s)	1.6.1	G	RO												
		26 13 01	SD-02 Shop Drawings															
			Switchgear Drawings	1.6.1	G	DO												
			SD-03 Product Data															
			Fuse Time-Current Characteristic	1.6.3	G	DO												
			Curves															
			Air Insulated Pad-mounted	2.1	G	DO												
			Switchgear															
			Insulated High-Voltage	2.2	G	DO												
			Connectors															
			Surge Arresters	2.3	G	DO												
			SD-06 Test Reports															
			Acceptance Checks and Tests	3.4.1	G	RO												
			SD-07 Certificates															
			Paint Coating System	1.6.2	G	RO												
			SD-09 Manufacturer’s Field															
			Reports															
			Switchgear Design and	2.6.1	G	RO												
			Production Tests															
			SD-10 Operation and Maintenance															
			Data															
			Air Insulated Pad-Mounted	1.7.1	G	RO												
			Switchgear Operation and															
			Maintenance															

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		26 13 13	SD-02 Shop Drawings															
			Switchgear Drawings	1.8.2	G	DO												
			SD-03 Product Data															
			Switchgear	2.3	G	DO												
			SD-06 Test Reports															
			Notice of the Proposed Dates of	3.2														
			Factory Inspections and Tests															
			Factory Test Procedures	3.2	G	DO												
			Switchgear Design Tests	2.6.3	G	DO												
			Production Test	1.9.2	G	DO												
			Acceptance Checks and Tests	3.11.1	G	DO												
			SD-07 Certificates															
			Cybersecurity Equipment	2.6.2	G	HNC												
			Certification															
			Cybersecurity Installation	3.11.1.7	G	HNC												
			Certification															
			SD-10 Operation and Maintenance															
			Data															
			Switchgear Operation and	1.9.1	G	RO												
			Maintenance															
			Generator Controls Sequence of	3.2	G	DO												
			Operations															
			SD-11 Closeout Submittals															
			Assembled Operation and	1.9.2	G	RO												
			Maintenance Manuals															
			Equipment Test Schedule	2.6.1	G	RO												

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		26 13 13	Request for Settings	3.11	G	DO												
			Service Entrance Available Fault	2.9	G	DO												
			Current Label															
		26 20 00	SD-02 Shop Drawings															
			Underground Conduit Routing	1.8	G	DO												
			Plan															
			Panelboards	2.14	G	DO												
			CFCI Equipment Electrical Data	2.35.1	G	DO												
			Interim CFCI Equipment	2.35.2	G	DO												
			Electrical Data															
			Interim CFCI Equipment	2.35.2	G	DO												
			Electrical Data (Fire Alarm)															
			Interim CFCI Equipment	2.35.2	G	DO												
			Electrical Data (Generator Station															
			Service)															
			Interim CFCI Equipment	2.35.2	G	DO												
			Electrical Data (Filter Shelter)															
			Interim CFCI Equipment	2.35.2	G	DO												
			Electrical Data (Offload)															
			Busway	2.3	G	DO												
			Cable Trays	2.4	G	DO												
			Wireways	2.28	G	DO												
			Marking Strips	3.1.11.1	G	DO												
			SD-03 Product Data															
			Receptacles	2.13	G	DO												
			Circuit Breakers (Switchboards)	2.14.3	G	DO												

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		26 20 00	Circuit Breakers (Other then Switchboards)	2.14.3	G	DO												
			Switches	2.11	G	DO												
			Manual Transfer Switch	2.11.4	G	DO												
			Low- to Low-Voltage Transformers	2.16.1	G	DO												
			Medium- to Low-Voltage Transformers	2.16.2	G	DO												
			Enclosed Circuit Breakers	2.14.3.7	G	DO												
			Motor Controllers	2.18	G	DO												
			Manual Motor Starters	2.19	G	DO												
			Metering	2.29	G	DO												
			Secondary Bonding Busbar	2.22.3	G	DO												
			Surge Protective Devices	2.30	G	DO												
			Cable Trays	2.4	G	DO												
			Adjustable Circuit Breaker Settings Cover	2.14.3.4.2	G	DO												
			Circuit Breaker Handle Locks and Lock-out Device	2.14.3.6	G	DO												
			Sealoffs	3.1.2.1	G	DO												
			Conductor Termination Adapters	2.33	G	DO												
			Cable Tray Design	2.4	G	DO												
			SD-06 Test Reports															
			600-volt Wiring Test	3.5.2	G	RO												
			Grounding System Test	3.5.6	G	RO												

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		26 20 00	Low- to Low-Voltage Transformer Tests	3.5.3.1	G	RO												
			Medium- to Low-Voltage Transformer Tests	3.5.3.2	G	RO												
			Ground-fault Receptacle Test	3.5.4	G	RO												
			Arc-fault Receptacle Test	3.5.5	G	RO												
			SD-07 Certificates															
			Fuses	2.12	G	RO												
			SD-09 Manufacturer’s Field Reports															
			Low- to Low-Voltage Transformer Factory Tests	2.32.1.1														
			Medium- to Low-Voltage Transformer Factory Tests	2.32.1.2														
			SD-10 Operation and Maintenance Data															
			Electrical Systems	1.5.1	G	RO												
			Metering	2.29	G	RO												
		26 24 13	SD-02 Shop Drawings															
			Switchboard Drawings	1.5.2	G	DO												
			SD-03 Product Data															
			Switchboard	2.2	G	DO												
			SD-06 Test Reports															
			Switchboard Design Tests	2.5.2	G	DO												
			Switchboard Production Tests	2.5.3	G	DO												
			Acceptance Checks and Tests	3.6.1	G	DO												

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		26 24 13	SD-07 Certificates																
			Cybersecurity Installation Certification	3.6.1.7	G	HNC													
			SD-10 Operation and Maintenance Data																
			Switchboard Operation and Maintenance	1.6.1	G	RO													
			SD-11 Closeout Submittals																
			Assembled Operation and Maintenance Manuals	1.6.2	G	RO													
			Equipment Test Schedule	2.5.1	G	RO													
			Request for Settings	3.6	G	RO													
			Required Settings	3.6	G	RO													
		26 29 23	SD-02 Shop Drawings																
			Schematic Diagrams	1.5.1	G	DO													
			Schematic Diagrams (Generator Supply Fans)	1.5.1	G	DO													
			Interconnecting Diagrams	1.5.2	G	DO													
			Installation Drawings	1.5.3	G	DO													
			As-Built Drawings	1.5.3	G	RO													
			SD-03 Product Data																
			Adjustable Speed Drives	2.1	G	DO													
			Adjustable Speed Drives (Generator Supply Fans)	2.1	G	DO													
			Wires and Cables	2.3															
			Equipment Schedule	1.5.4															

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		26 29 23	SD-06 Test Reports																
			ASD Test	3.3.1															
			Performance Verification Tests	3.3.2															
			Endurance Test	3.3.3															
			SD-08 Manufacturer’s Instructions																
			Installation instructions	1.5.5															
			SD-09 Manufacturer’s Field																
			Reports																
			ASD Test Plan	2.5.1	G	RO													
			Standard Products	1.5.6															
			Testing Agency's Field	3.3.1															
			Supervisor																
			SD-10 Operation and Maintenance																
			Data																
			Adjustable Speed Drives	2.1															
		26 32 15	SD-02 Shop Drawings																
			Engine-Generator Set and	2.1.1	G	DO													
			Auxiliary Equipment																
			Load Bank	2.18	G	DO													
			Auxiliary Systems	1.4.10	G	DO													
			Detailed Drawings	1.4.9	G	DO													
			SD-03 Product Data																
			Harmonic Requirements	2.1.9	G	DO													
			Engine-Generator Set		G	DO													
			Efficiencies																
			Emissions	2.13	G	DO													

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		26 32 15	filters	2.7.2	G	DO												
			special tools	2.15	G	RO												
			Engine-Generator Parameter	2.1.1	G	DO												
			Schedule															
			Heat Exchanger	2.8.2	G	DO												
			Generator	2.16	G	DO												
			Manufacturer's Catalog	2.5														
			Load Bank	2.18	G	DO												
			Load Bank Connection Cabinet	2.19	G	DO												
			Site Welding	1.4.2	G	RO												
			Spare Parts	1.7.2	G	RO												
			Onsite Training	3.11	G	RO												
			Vibration-Isolation	2.1.8	G	DO												
			Posted Data and Instructions	3.12	G	RO												
			Instructions	3.5.7.1	G	RO												
			Experience	1.4.7														
			Field Engineer	1.4.8	G	RO												
			General Installation	3.1	G	RO												
			Exciter	2.17	G	DO												
			SD-05 Design Data															
			Performance Criteria	2.16	G	DO												
			Power Factor	3.5.1.2	G	DO												
			Heat Exchanger	2.8.2	G	DO												
			Time-Delay on Alarms	2.22.5	G	DO												
			Cooling System	2.8	G	DO												
			Vibration Isolation	2.1.8	G	DO												

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		26 32 15	Battery Charger	2.14.3.2	G	DO													
			Capacity Calculations for	2.1.1	G	DO													
			Engine-Generator Set																
			Brake Mean Effective Pressure	2.1.1	G	DO													
			(BMEP) Calculations																
			Torsional Vibration Stress	2.1.1	G	DO													
			Analysis Computations																
			Turbocharger Load Calculations	2.1.1	G	DO													
			SD-06 Test Reports																
			Performance Tests;	3.5.9	G	RO													
			Factory Inspection and Tests	2.30	G	RO													
			Factory Tests	2.30.2	G	RO													
			Onsite Inspection and Tests	3.5	G	RO													
			Acceptance Checks and Tests	3.8.2	G	RO													
			Functional Acceptance Tests	3.9.2	G	DO													
			Maintenance Procedures	3.11	G	RO													
			Operation and Maintenance	3.11	G	RO													
			Manuals																
			Inspections	3.5.3	G	RO													
			Functional Acceptance Test	3.8.6	G	DO													
			Procedure																
			SD-07 Certificates																
			Cooling System	2.8	G	RO													
			Vibration Isolation	2.1.8	G	RO													
			Prototype Test	2.30.2	G	RO													
			Reliability and Durability	2.1.5	G	RO													

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		26 32 15	Fuel System Certification	1.4.13	G	RO												
			Start-Up Engineer	3.7	G	RO												
			Instructor's Qualification Resume	3.10.1	G	RO												
			Engine Emission Limits	2.1.2.1	G	RO												
			Current Balance	2.16.1														
			Materials and Equipment	2.4	G	RO												
			Engine Tests	3.5.4	G	RO												
			Generator Tests	3.5.5	G	RO												
			Assembled Engine-Generator Set	3.5.6	G	RO												
			Tests															
			SD-10 Operation and Maintenance															
			Data															
			Preliminary Assembled Operation	3.8.5	G	RO												
			and Maintenance Manuals															
			Posted Data and Instructions	3.12	G	RO												
			Training Plan	3.10.2	G	RO												
			Acceptance	3.13	G	DO												
		26 36 23	SD-02 Shop Drawings															
			Automatic Transfer Switch	1.4.2	G	DO												
			Drawings															
			SD-03 Product Data															
			Automatic Transfer Switches	2.1	G	DO												
			By-Pass/Isolation Switch (BP/IS)	2.2	G	DO												
			SD-06 Test Reports															
			Acceptance Checks and Tests	3.3.1	G	RO												
			Functional Acceptance Tests	3.3.2	G	RO												

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		26 36 23	Factory Testing	2.4	G	RO												
			Factory Test Reports	2.4.2	G	RO												
			SD-07 Certificates															
			Proof of Listing	1.4.1	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	1.3	G	RO												
			Manual															
		26 41 00	SD-02 Shop Drawings															
			Overall lightning protection	1.4.1.1	G	DO												
			system															
			Each major component	1.4.1.2	G	DO												
			SD-06 Test Reports															
			Lightning Protection and	1.4.3	G	RO												
			Grounding System Test Plan															
			Lightning Protection and	3.5.1	G	RO												
			Grounding System Test															
			SD-07 Certificates															
			Lightning Protection System	1.2.3	G	RO												
			Installers Documentation															
			Component UL Listed and	1.4.2	G	RO												
			Labeled															
			Lightning protection system	1.4.4	G	RO												
			inspection certificate															
			Roof manufacturer's warranty	3.1.1	G	RO												
		26 42 13	SD-01 Preconstruction Submittals															

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		26 42 13	Preconstruction Survey	1.8.2															
			SD-02 Shop Drawings																
			Drawings	2.1.2.7	G	RO													
			Isolation flange kits	2.4.11															
			Anode junction boxes, bonding	2.3.4															
			boxes, and test stations																
			Joint bonds	3.5.4															
			Contractor's Modifications	2.1.2.7	G	RO													
			SD-03 Product Data																
			Qualifications	1.6.2															
			Equipment	1.5.1	G	RO													
			Anodes	1.5.1	G	RO													
			Anode junction boxes, bonding	2.3.4															
			boxes, and test stations																
			Dielectric unions	2.4.13															
			Wires	2.1.2.2															
			Cable and wire	2.4.3															
			Casings, isolation, and seals	3.5.5															
			Shunts	2.3.2															
			Permanent reference electrodes	2.4.7	G	RO													
			Spare Parts	1.5.1															
			SD-06 Test Reports																
			Tests and Measurements	3.6.1	G	RO													
			Contractor's Modifications	2.1.2.7	G	RO													
			SD-10 Operation and Maintenance																
			Data																

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		26 42 13	Cathodic Protection System	3.6	G	RO													
			Cathodic Protection System	3.6	G	RO													
			Training Course	1.5.1	G	RO													
			SD-11 Closeout Submittals																
			Initial Cathodic Protection System	3.6.1.12	G	RO													
			Field Testing																
			One Year Warranty Period	3.6.1.14	G	RO													
			Cathodic Protection System Field																
			Test Report																
			Final Cathodic Protection System	3.6.1.15	G	RO													
			Field Test Report																
		26 51 00	SD-02 Shop Drawings																
			Luminaire Drawings	1.5.1	G	DO													
			Sequence of Operation for	2.5.1	G	DO													
			Lighting Control System																
			SD-03 Product Data																
			Luminaires	2.2	G	DO													
			Light Sources	2.3	G	DO													
			LED Drivers	2.4	G	DO													
			Luminaire Warranty	1.6.1	G	RO													
			Luminaire Design Data	1.5.2	G	DO													
			Lighting Controls Warranty	1.6.2	G	RO													
			Local Area Controller	2.5.1.1.1	G	DO													
			Lighting Contactor	2.5.2	G	DO													
			Switches	2.5.3.1	G	DO													
			Wall Box Dimmers	2.5.3.2	G	DO													

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		26 51 00	Occupancy/Vacancy Sensors	2.5.3.3	G	DO												
			Photosensors	2.5.3.4	G	DO												
			Power Packs	2.5.3.3.3	G	DO												
			Power Hook Luminaire Hangers	2.7.4	G	DO												
			Exit Signs	2.6.1	G	DO												
			LED Emergency Lighting	2.6.2	G	DO												
			Transfer Switch															
			Central Emergency Lighting	2.6.4	G	DO												
			System															
			SD-06 Test Reports															
			ANSI/IES LM-79 Test Report	1.5.3	G	DO												
			ANSI/IES LM-80 Test Report	1.5.4	G	DO												
			ANSI/IES TM-21 Test Report	1.5.5	G	DO												
			Photosensor Verification Test	3.2.1.1	G	RO												
			SD-07 Certificates															
			LED Driver and Control System	1.5.6	G	RO												
			Interface Compatibility Certificate															
			SD-10 Operation and Maintenance															
			Data															
			End-User Training Plan	3.3.2.1	G	RO												
		26 56 00	SD-02 Shop Drawings															
			Luminaire Drawings	1.5.1.1	G	DO												
			Pole Drawings	1.5.1.2	G	DO												
			SD-03 Product Data															
			Luminaires	2.2	G	DO												
			Light Sources	2.3	G	DO												

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		26 56 00	LED Drivers	2.4	G	DO													
			Luminaire Warranty	1.6.1	G	RO													
			Lighting Controls Warranty	1.6.2	G	RO													
			Pole Warranty	1.6.3	G	RO													
			Photosensors	2.5.2.1	G	DO													
			Poles	2.6	G	DO													
			Brackets	2.6.1	G	DO													
			SD-05 Design Data																
			Luminaire Design Data	1.5.2	G	DO													
			SD-06 Test Reports																
			ANSI/IES LM-79 Test Report	1.5.3	G	DO													
			ANSI/IES LM-80 Test Report	1.5.4	G	DO													
			ANSI/IES TM-21 Test Report	1.5.5	G	DO													
			SD-08 Manufacturer’s Instructions																
			Poles	2.6	G	RO													
			SD-10 Operation and Maintenance																
			Data																
			Exterior Lighting Control System	1.7.2	G	DO													
			Maintenance Staff Training Plan	3.3.1.1	G	RO													
			End-User Training Plan	3.3.1.2	G	RO													
		27 10 00	SD-02 Shop Drawings																
			Underground Conduit Routing	1.11	G	DO													
			Plan																
			Telecommunications Drawings	1.6.1.1	G	DO													
			Telecommunications Space	1.6.1.2	G	DO													
			Drawings																

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		27 10 00	SD-03 Product Data															
			Telecommunications Cabling	2.3	G	RO												
			Patch Panels	2.4.5	G	RO												
			Telecommunications	2.5	G	RO												
			Outlet/Connector Assemblies															
			Equipment Support Frame	2.4.2	G	RO												
			Connector Blocks	2.4.3	G	RO												
			Spare Parts	1.10.3	G	RO												
			SD-06 Test Reports															
			Telecommunications Cabling	3.5.1	G	RO												
			Testing															
			SD-07 Certificates															
			Telecommunications Contractor	1.6.2.1	G	RO												
			Key Personnel	1.6.2.2	G	RO												
			Manufacturer Qualifications	1.6.2.3	G	RO												
			Test Plan	1.6.3	G	RO												
			SD-09 Manufacturer’s Field															
			Reports															
			Factory Reel Tests	2.10.1	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Telecommunications Cabling and	1.10.1	G	RO												
			Pathway System															
			SD-11 Closeout Submittals															
			Record Documentation	1.10.2	G	RO												
		27 51 23	SD-02 Shop Drawings															

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		27 51 23	Installation	3.2	G	DO													
			SD-03 Product Data																
			All-Call Amplifier	2.1.5.2	G	DO													
			Cone-Type Loudspeakers	2.1.5.7	G	DO													
			Horn-Type Loudspeakers	2.1.5.8	G	DO													
			Intercommunication Amplifier	2.1.5.1	G	DO													
			Master Station	2.2.1	G	DO													
			Remote Audio-Only Station	2.1.5.5	G	DO													
			Remote Audio Station	2.1.5.6	G	DO													
			Speaker Enclosures	2.3	G	DO													
			Spare Parts	1.6	G	RO													
			SD-06 Test Reports																
			Acceptance Tests	3.6	G	RO													
			SD-10 Operation and Maintenance																
			Data																
			All-Call Amplifier	2.1.5.2	G	RO													
			Intercommunication Amplifier	2.1.5.1	G	RO													
			Master Station	2.2.1	G	RO													
		28 31 70	SD-01 Preconstruction Submittals																
			Qualified Fire Protection Engineer	1.3.2	G	DO													
			(QFPE)																
			Fire alarm system designer	1.8.2.1	G	DO													
			Supervisor	1.8.2.2	G	DO													
			Technician	1.8.2.3	G	DO													
			Installer	1.8.2.4	G	DO													
			Test Technician	1.8.2.5	G	DO													

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		28 31 70	Fire Alarm System Site-Specific	1.7	G	DO												
			Software Acknowledgement															
			SD-02 Shop Drawings															
			Nameplates	1.8.1.2	G	RO												
			Instructions	2.2.4	G	RO												
			Wiring Diagrams	1.8.1.3	G	DO												
			System Layout	1.8.1.4	G	DO												
			Notification Appliances	1.8.1.5	G	DO												
			Initiating devices	1.8.1.6	G	DO												
			Battery Power (Other than RSCP)	1.8.1.7	G	DO												
			Voltage Drop Calculations (Other	1.8.1.8	G	DO												
			than RSCP)															
			Dedicated Emergency Panel	2.16.1	G	DO												
			Schedules															
			SD-03 Product Data															
			Fire Alarm Control Unit (FACU)	2.3	G	DO												
			LCD Annunciator	2.4.1	G	DO												
			Manual Stations	2.5	G	DO												
			Smoke Detectors	2.6	G	DO												
			Duct Smoke Detectors	2.6.2	G	DO												
			Addressable Interface Devices	2.12	G	DO												
			Addressable Control Modules	2.13	G	DO												
			Isolation Modules	2.14	G	DO												
			Notification Appliances	1.8.1.5	G	DO												
			Batteries	2.17.1	G	DO												
			Battery Chargers	2.17.2	G	DO												

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		28 31 70	Supplemental Notification	2.17.1.1	G	DO												
			Appliance Circuit Panels															
			Level Sensor	2.21.4	G	DO												
			Auxiliary Power Supply Panels	2.17.1.1	G	DO												
			Surge Protective Devices	2.18	G	DO												
			Alarm Wiring	2.18	G	DO												
			Back Boxes and Conduit	3.3.4	G	DO												
			Ceiling Bridges	3.2.7	G	DO												
			Terminal Cabinets	3.3.2	G	DO												
			Automatic Fire Alarm	2.20	G	DO												
			Transmitters															
			Radio Transmitter and Interface	2.20.1	G	DO												
			Panels															
			Environmental Enclosures or	2.22	G	DO												
			Guards															
			Hydrogen Detectors	2.8	G	DO												
			Carbon Monoxide Detectors	2.9	G	DO												
			Low Temperature Sensors	2.21.3	G	DO												
			Solenoid Disconnect Switches	2.21.7	G	DO												
			Pressure Switches	2.21.5	G	DO												
			Spare Parts	1.10.1	G	DO												
			Equipment List	1.8.1.9	G	DO												
			SD-06 Test Reports															
			Test Procedures	3.6.1	G	RO												
			Smoke Sensor Testing	2.6.3	G	RO												
			SD-07 Certificates															

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		28 31 70	Verification of Compliant	3.6.2.1	G	RO												
			Installation															
			Request for Government Final	3.6.2.2	G	RO												
			Test															
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	3.8	G	RO												
			(O&M) Instructions															
			Instruction of Government	3.9	G	RO												
			Employees															
			Training Documentation	3.9.3	G	RO												
			SD-11 Closeout Submittals															
			As-Built Drawings	1.8.1.11														
			Document Storage Cabinet	3.12.4														
			Spare Parts	1.10.1														
		31 00 00	SD-01 Preconstruction Submittals															
			Excavation and Trenching Plan	3.1.3	G	RO												
			Dewatering Work Plan	3.1.2.2	G	RO												
			Disposition of Surplus Materials	3.9	G	RO												
			Preconstruction Meeting	1.6.4	G	RO												
			SD-03 Product Data															
			Flowable Fill Mix Design	2.2	G	RO												
			Geotextiles	2.6														
			SD-04 Samples															
			Geotextiles	2.6														
			SD-06 Test Reports															

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CONTRACT NO.

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CONTRACTOR

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		31 00 00	Borrow Site Testing	3.2.2	G	RO												
			Pipe Inspection Report	3.6.1.7	G	RO												
			Material Test Reports	3.10	G	RO												
		31 11 00	SD-03 Product Data															
			Tree Wound Paint	2.1.1														
		32 01 19.61	SD-03 Product Data															
			Sealants	2.1	G	RO												
			Manufacturer's	3.5.2														
			Recommendations															
			SD-04 Samples															
			Sealants	2.1														
			Blocking Media/Backup Materials	2.3.1														
			Backer Rod	3.3.4.1														
			Bond Breaking Tapes	2.3.2														
			SD-06 Test Reports															
			Sealants	2.1														
			SD-07 Certificates															
			Equipment List	3.1														
			SD-08 Manufacturer’s Instructions															
			Sealants	2.1														
		32 05 33	SD-01 Preconstruction Submittals															
			Integrated Pest Management	2.4	G	RO												
			Plan															
			SD-03 Product Data															
			Fertilizer	2.1	G	RO												
			Mulches Topdressing	2.3	G	RO												

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		32 05 33	Organic Mulch Materials	2.3.1	G	RO												
			SD-07 Certificates															
			Maintenance Inspection Report	3.3.1	G	RO												
		32 10 00.00	SD-03 Product Data															
			Plant, Equipment, and Tools	1.10														
			Job Mix Formula	2.2.1	G	RO												
			Mixture Proportions	2.4.1.2	G	RO												
			SD-06 Test Reports															
			Initial Tests	2.12	G	RO												
			Contractor Quality Control	3.2.3	G	RO												
			Contractor Quality Control	3.4.6	G	RO												
			Acceptability of Work	3.2.4	G	RO												
			Acceptability of Work	3.4.7	G	RO												
			Acceptability of Work	3.6.1	G	RO												
			SD-07 Certificates															
			Asphalt Cement Binder	2.1	G	RO												
			Asphalt Cement Binder	2.2.2	G	RO												
			Bituminous Tack and Prime Coat	2.3	G	RO												
			Testing Laboratory	3.2.2	G	RO												
			Testing Laboratory	3.4.7.1	G	RO												
			SD-08 Manufacturer’s Instructions															
			Manufacturer's	3.4.5	G	RO												
			Recommendations															
		32 11 20	SD-03 Product Data															
			Plant, Equipment, and Tools	2.3	G	RO												
			SD-06 Test Reports															

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		32 11 20	Initial Tests	2.2.1	G	RO												
			In-Place Tests	3.12.1	G	RO												
		32 11 23	SD-03 Product Data															
			Plant, Equipment, and Tools	2.4	G	RO												
			SD-06 Test Reports															
			Initial Tests	2.3.1	G	RO												
			In-Place Tests	3.13.1	G	RO												
		32 12 13	SD-06 Test Reports															
			Sampling and Testing	3.4.1														
			SD-07 Certificates															
			Certificates Of Compliance	3.4														
			(COC)															
		32 13 13.06	SD-03 Product Data															
			Curing Materials	2.1.6														
			Reinforcement	2.1.5.3														
			Epoxy Resin	2.1.8														
			Epoxy Resin	2.1.8														
			Dowel Bars	2.1.5.1														
			Expansion Joint Filler	2.1.9.1														
			SD-04 Samples															
			Test Section	1.5.2														
			SD-05 Design Data															
			Mix Design Report	2.2.2	G	RO												
			SD-06 Test Reports															
			Concrete Slump Tests	3.7.2														
			Concrete Uniformity	2.3.1														

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		32 13 13.06	Flexural Strength	3.7.3															
			Air Content	3.7.4															
			SD-07 Certificates																
			Batch Tickets	1.3.3															
			NRMCA Certificate Of	1.3.1															
			Conformance																
		32 16 19	SD-03 Product Data																
			Concrete	2.1															
			SD-06 Test Reports																
			Field Quality Control	3.8															
		32 31 13	SD-02 Shop Drawings																
			Location of Gate, Corner, End,	3.1.2.1															
			and Pull Posts																
			Erection/Installation Drawings	Part 3	G	RO													
			SD-03 Product Data																
			Fence Assembly	2.1	G	RO													
			Gate Assembly	2.1	G	RO													
			Gate Hardware and Accessories	2.2.5	G	RO													
			SD-07 Certificates																
			Certificates of Compliance	1.3.1															
			SD-08 Manufacturer’s Instructions																
			Fence Assembly	2.1															
			Gate Assembly	2.1															
			Hardware Assembly	2.1															
			Accessories	2.1															
		32 92 19	SD-03 Product Data																

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		32 92 19	Equipment	3.2.5	G	RO												
			Fertilizer	2.4														
			Herbicide	1.5.2	G	RO												
			Herbicide	2.6	G	RO												
			Herbicide	2.6	G	RO												
			Seed Mix	2.1.4	G	DO												
			SD-06 Test Reports															
			Topsoil Composition Tests	2.2.3	G	RO												
			Seed Lab Analysis	2.1.2	G	DO												
			SD-07 Certificates															
			Herbicide	1.5.2	G	RO												
			Herbicide	2.6	G	RO												
			Herbicide	2.6	G	RO												
			Seed	2.1	G	DO												
			SD-08 Manufacturer’s Instructions															
			Erosion Control Materials	2.8														
			SD-11 Closeout Submittals															
			Plant Establishment Period	3.5														
		33 01 50.31	SD-02 Shop Drawings															
			Leak Detection System	2.3	G	DO												
			Electronic Monitoring/Alarm	2.4	G	DO												
			Panel															
			SD-03 Product Data															
			Leak Detection System	2.3	G	DO												
			Electronic Monitoring/Alarm	2.4	G	DO												
			Panel															

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		33 01 50.31	SD-06 Test Reports															
			Leak Detection System Test	3.2.1														
			SD-07 Certificates															
			Demonstrations	3.3														
			SD-08 Manufacturer’s Instructions															
			Leak Detection System	2.3														
			SD-10 Operation and Maintenance															
			Data															
			Leak Detection System	2.3	G	RO												
			Electronic Monitoring/Alarm	2.4	G	RO												
			Panel															
		33 05 23	SD-01 Preconstruction Submittals															
			Boring and Jacking Plan	1.5	G	RO												
			Statement of Contractor	1.5														
			Qualifications															
			SD-03 Product Data															
			Pipe casing	2.3.1	G	DO												
			SD-05 Design Data															
			Design calculations for pipe	2.1.1.2	G	DO												
			casing															
			Access Shaft Construction Plan	1.5	G	DO												
			Access Shaft Construction Plan	3.1.1	G	DO												
			SD-06 Test Reports															
			Monitoring Survey	3.5.1.1	G	RO												
			SD-08 Manufacturer’s Instructions															
			Installation	3.3	G	RO												

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		33 05 23	Safety Data Sheets	1.9.1.2	G	RO												
			SD-11 Closeout Submittals															
			Record Drawings	3.6.3	G	RO												
			Daily Work Logs of installation	3.6.3	G	RO												
			operations															
		33 08 55	SD-01 Preconstruction Submittals															
			Copies of API RP 1595	1.3.2	G	DO												
			System Start-Up Plan	1.3.4	G	DO												
			Performance Testing Plan	1.3.1	G	DO												
			Fuel Provisioning Plan	1.3.1	G	RO												
			SD-06 Test Reports															
			Final Reports	1.5.1	G	DO												
			Equipment Tests	3.8	G	DO												
			Piping Flushing Checklist	3.6.3	G	DO												
			SD-07 Certificates															
			Fuel Testing Laboratory	1.3.3	G	RO												
			Qualifications															
			Certification (Ready for Start-Up	1.3.7	G	DO												
			and Performance Testing)															
			Contractor Start-Up Qualifications	1.6.1	G	RO												
			Certificate of Calibration	2.2.1	G	RO												
			Disposal Of Waste Materials	1.8														
			SD-11 Closeout Submittals															
			Certification of Entire System	1.6.2														
		33 09 52	SD-02 Shop Drawings															
			Shop Drawing	3.4.1	G	DO												

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		33 09 52	SD-03 Product Data																
			Tools and Spare Parts	1.4															
			Laptop Computer	2.1.17	G	DO													
			Programmable Logical Controller	2.2	G	DO													
			(PLC) Hardware and Software																
			Programmable Logical Controller	3.2	G	DO													
			(PLC) Hardware and Software																
			Control Wiring Data Lists	3.1.2	G	DO													
			Human Machine Interface (HMI)	2.1.5	G	DO													
			Fiber Converter Panels (FCP)	2.1.2	G	DO													
			and Components																
			Pump Control Panels (PCP) and	2.1.1	G	DO													
			Components																
			Pump Control Panels (PCP) and	3.1	G	DO													
			Components																
			Graphics Display Screen	3.3	G	DO													
			SD-06 Test Reports																
			Certified Pump Control Panels	3.1.3	G	DO													
			(PCP) Shop Test Reports																
			Record of Test	3.4.2															
			SD-07 Certificates																
			Experience and Qualifications	1.5	G	DO													
			Testing Plan	3.4.2	G	DO													
			Training Plan for Instructing	3.4.3	G	DO													
			Personnel																

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		33 09 52	SD-10 Operation and Maintenance																
			Data																
			Operation and Maintenance	1.2	G	DO													
			Manuals																
		33 11 00	SD-01 Preconstruction Submittals																
			Connections	3.1.1	G	RO													
			SD-03 Product Data																
			Pipe, Fittings, Joints and	2.1.1	G	RO													
			Couplings																
			Valves	2.1.2	G	RO													
			Fire Hydrants	2.1.4.1	G	RO													
			Pipe Restraint	2.2.1	G	RO													
			Tapping Sleeves	2.2.2	G	RO													
			Corporation Stops	2.2.8.1	G	RO													
			Precast Concrete Thrust Blocks	2.2.1.2	G	RO													
			Disinfection Procedures	3.2.2	G	RO													
			SD-06 Test Reports																
			Bacteriological Samples	3.3.1.3	G	RO													
			Post-Construction Fusion Report	3.2.1.5.1	G	RO													
			Leakage Test	3.3.1.2	G	RO													
			Hydrostatic Test	3.3.1.1	G	RO													
			SD-07 Certificates																
			Pipe, Fittings, Joints and	2.1.1	G	RO													
			Couplings																
			Lining for Fittings	2.1.1.1.1	G	RO													
			Valves	2.1.2	G	RO													

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		33 11 00	Fusion Technician Qualifications	1.4.2.1	G	RO												
			SD-08 Manufacturer's Instructions															
			PVC Piping	2.1.1.1.1	G	RO												
			PVC Piping For Service Lines	2.1.1.1.2	G	RO												
		33 30 00	SD-01 Preconstruction Submittals															
			Contractor's License	1.3.1	G	RO												
			SD-02 Shop Drawings															
			Installation Drawings	3.1.1	G	RO												
			SD-03 Product Data															
			Precast Concrete Manholes	2.2.5	G	RO												
			Frames, Covers, and Gratings	2.2.8	G	RO												
			SD-06 Test Reports															
			Precast Concrete Sewer Manhole Test	3.3.1.2.1	G	RO												
			Hydrostatic Sewer Test	3.3.1.1	G	RO												
			Negative Air Pressure Test	3.3.1.2.1	G	RO												
			Low-Pressure Air Tests	3.3.1.2.2	G	RO												
			Deflection Testing	3.3.1.3	G	RO												
			SD-07 Certificates															
			Portland Cement	2.2.3														
			Pre-Installation Inspection Request	3.3.2.1	G	RO												
			Post-Installation Inspection Request	3.3.2.2	G	RO												
		33 40 00	SD-07 Certificates															
			Frame and Cover or Gratings	2.3.6	G	RO												

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		33 40 00	SD-08 Manufacturer's Instructions															
			Placing Pipe	3.3	G	RO												
			SD-11 Closeout Submittals															
			Post-Installation Inspection	3.8.1.1.3	G	RO												
			Report															
			LID Verification Report	3.8.1.2	G	RO												
		33 52 10	SD-02 Shop Drawings															
			Grounding and Bonding	2.1.2														
			Pipe Supports	2.5.8														
			SD-03 Product Data															
			Stainless Steel Pipe	2.4.1	G	RO												
			Flexible Non-Metallic Pipe	2.4.2	G	RO												
			Steel Reinforced Flexible Pipe	2.4.3	G	RO												
			Joint Compound	2.5.4	G	RO												
			Strainer	2.5.5	G	DO												
			Thermometers	2.5.6	G	DO												
			Pressure Gauge	2.5.7	G	DO												
			Ball Valves	2.6.1	G	DO												
			Swing Type Check Valves	2.6.2	G	RO												
			Tank Overfill Prevention Valve	2.6.3	G	DO												
			(Pumped Fuel Receipt)															
			Diaphragm Pump	2.7.1	G	DO												
			Pump Control Panel	2.7.2	G	DO												
			SD-06 Test Reports															
			Preliminary Pneumatic Test	3.3.2.1														
			Final Pneumatic Test	3.3.2.2														

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		33 52 10	Hydrostatic Test	3.3.2.3															
			Exterior Containment Piping	3.3.2.4															
			Tests																
			SD-07 Certificates																
			Contractor Qualifications	1.4.1	G	RO													
			Licensed Personnel	1.4.2.1															
			Pipeline Inventory	1.4.3.1	G	RO													
			Demonstrations	3.5															
			SD-10 Operation and Maintenance																
			Data																
			Strainer	2.5.5	G	RO													
			Thermometers	2.5.6	G	RO													
			Ball Valves	2.6.1	G	RO													
			Swing Type Check Valves	2.6.2	G	RO													
			Tank Overfill Prevention Valve	2.6.3	G	RO													
			(Pumped Fuel Receipt)																
			Diaphragm Pump	2.7.1	G	RO													
			Pump Control Panel	2.7.2	G	RO													
		33 52 23.15	SD-01 Preconstruction Submittals																
			Welding Procedure Specifications	1.6	G	DO													
			(WPS)																
			Welder Performance Qualification	1.6	G	DO													
			(WPQ)																
			Procedure Qualification Record	1.6	G	DO													
			(PQR)																
			Welding Operations	3.1	G	DO													

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		33 52 23.15	SD-02 Shop Drawings																
			POL Service Piping	1.6.2	G	DO													
			SD-06 Test Reports																
			Examinations, Inspections and	3.2	G	RO													
			Tests																
			SD-07 Certificates																
			Qualifications	1.6	G	RO													
		33 52 40	SD-01 Preconstruction Submittals																
			Work Plan	1.5.3	G	RO													
			Hydrotesting Plan	1.5.4	G	DO													
			Quality Assurance Plan	2.2.2	G	RO													
			SD-02 Shop Drawings																
			Grounding and Bonding	2.1.2															
			Pipe Supports	2.5.5	G	DO													
			SD-03 Product Data																
			Stainless Steel Piping	2.2.2	G	DO													
			Flexible Non-Metallic Pipe	2.2.4	G	DO													
			Fittings	2.2.5	G	DO													
			Insulating Flange Kits	2.2.6	G	DO													
			Lightning Surge Arrester	2.2.6	G	DO													
			Bolts, Nuts And Washers	2.2.7	G	DO													
			Flange Protectors	2.2.10	G	DO													
			Ball Valves	2.3.1	G	DO													
			V Port Ball Valve	2.3.1.2	G	DO													
			Plug (Double Block and Bleed)	2.3.2	G	DO													
			Valves																

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		33 52 40	Electric Valve Actuator	2.3.2.5	G	DO													
			Swing Check Valves	2.3.3	G	DO													
			Silent Check Valves	2.3.4	G	DO													
			Thermal Relief Valve	2.4	G	DO													
			Thermal Relief Valve	2.4.2	G	DO													
			Mechanically Adjustable	2.5.1	G	DO													
			Segmented Elastomeric Seal																
			Pipe Sleeves	2.5.2	G	DO													
			Strainers	2.5.3	G	DO													
			Sample Connections	2.5.6	G	DO													
			Sight Flow Indicators	2.5.8	G	DO													
			Flexible Hose Connectors	2.6	G	DO													
			Automatic Air Vent	2.7	G	DO													
			Buried Utility Tape	2.8.5	G	RO													
			Pipeline Markers	2.8.6	G	RO													
			Flange Gaskets, Non-Metallic,	2.2.8	G	DO													
			Non-Electrically Isolating																
			Flange Gaskets, Metallic	2.2.9	G	DO													
			Heat Trace	2.5.9	G	DO													
			Double Wall Piping	2.2.3	G	DO													
			Tank Overfill Prevention Valve	2.2.11	G	DO													
			(Pumped Fuel Receipt)																
			Pipe Insulation Systems	2.5.7	G	DO													
			SD-06 Test Reports																
			Pneumatic Test	3.11.2	G	DO													
			Hydrostatic Test	3.11.3	G	DO													

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		33 52 40	Performance Testing	3.11.4	G	DO												
			SD-07 Certificates															
			Contractor Qualifications	1.5.1	G	RO												
			System Supplier	1.5.2	G	RO												
			Pipeline Inventory	1.5.5.1	G	RO												
			Qualifications of Owner's	2.2.2	G	RO												
			Inspector															
			Survey Final Elevations	3.5.7	G	RO												
			Demonstrations	3.12														
			SD-10 Operation and Maintenance															
			Data															
			Insulating Flange Kits	2.2.6	G	RO												
			Lightning Surge Arrester	2.2.6	G	RO												
			Ball Valves	2.3.1	G	RO												
			V Port Ball Valve	2.3.1.2	G	RO												
			Plug (Double Block and Bleed)	2.3.2	G	RO												
			Valves															
			Electric Valve Actuator	2.3.2.5	G	RO												
			Swing Check Valves	2.3.3	G	RO												
			Thermal Relief Valve	2.4	G	RO												
			Thermal Relief Valve	2.4.2	G	RO												
			Mechanically Adjustable	2.5.1	G	RO												
			Segmented Elastomeric Seal															
			Strainers	2.5.3	G	RO												
			Sample Connections	2.5.6	G	RO												
			Sight Flow Indicators	2.5.8	G	RO												

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		33 52 40	Automatic Air Vent	2.7	G	RO												
		33 52 43.14	SD-02 Shop Drawings															
			Control Valves	2.2	G	DO												
			SD-03 Product Data															
			Control Valves	2.2	G	DO												
			SD-06 Test Reports															
			Control Valves	2.2														
			SD-07 Certificates															
			Previous Air Force/Military	1.4.1	G	RO												
			Projects															
			Qualified Engineers	1.4.1	G	RO												
			Field Assistance	1.4.1	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	1.4.2	G	RO												
			Manuals															
		33 52 43.28	SD-02 Shop Drawings															
			Filter Separator	2.3	G	DO												
			SD-03 Product Data															
			Filter Separator	2.3	G	DO												
			Heating Element	2.4.6	G	DO												
			SD-07 Certificates															
			Filter Separator	2.3														
			SD-10 Operation and Maintenance															
			Data															
			Filter Separator	2.3	G	RO												

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		33 56 10	SD-02 Shop Drawings															
			Grounding and Bonding	2.1.1														
			Aboveground Lube Oil Storage	2.4.2	G	DO												
			Tank (Double Wall Steel)															
			SD-03 Product Data															
			Aboveground Storage Tank	2.4.1	G	DO												
			(Single Wall Steel)															
			Aboveground Lube Oil Storage	2.4.2	G	DO												
			Tank (Double Wall Steel)															
			Underground Storage Tank	2.5	G	DO												
			Tank Protective Coatings	2.6	G	DO												
			Atmospheric Vent	2.7.6.1	G	DO												
			Emergency Vent	2.7.6.2	G	DO												
			Tank Gauges	2.8	G	DO												
			Manhole Containment Sump	2.9	G	DO												
			SD-06 Test Reports															
			Aboveground Storage Tank	3.2.1	G	RO												
			Tightness Tests															
			Underground Storage Tank	3.2.2	G	RO												
			Tightness Tests															
			Tank Manufacturer's Tests	3.2.3	G	RO												
			Tank Fill Tests	3.4	G	RO												
			Tank Inspection Reports	3.2.5	G	RO												
			SD-07 Certificates															
			Contractor Qualifications	1.4.1	G	RO												
			Manufacturer	1.4.1	G	RO												

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		33 56 10	State	1.4.1	G	RO												
			Pollution Liability Insurance	1.4.1	G	RO												
			Permitting	1.4.2.1	G	RO												
			Registration	1.4.2.2	G	RO												
			Licensed Personnel	1.4.2.3	G	RO												
			Demonstrations	3.3	G	RO												
			STI SP001 Inspector's	3.2.5	G	RO												
			Certification															
			SD-08 Manufacturer’s Instructions															
			Underground Storage Tank	2.5	G	RO												
			Tank Gauges	2.8	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Aboveground Storage Tank	2.4	G	RO												
			Underground Storage Tank	2.5	G	RO												
			Tank Gauges	2.8	G	RO												
		33 57 55	SD-02 Shop Drawings															
			Grounding and Bonding	2.3.1	G	RO												
			Meters	2.7	G	DO												
			Packaged Truck Offload System	2.9	G	DO												
			High Point Vent and Low Point	2.12	G	DO												
			Drain Pits															
			SD-03 Product Data															
			Pressure Gages	2.4	G	DO												
			DIFFERENTIAL PRESSURE	2.5	G	DO												
			GAUGE															

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		33 57 55	Automatic Pump Controls	2.6	G	DO													
			Flow Switches	2.6.4	G	DO													
			Meters	2.7	G	DO													
			Submersible Pump	2.8.1	G	DO													
			Gear Pump	2.8.3	G	DO													
			Packaged Truck Offload System	2.9	G	DO													
			Filter/Separator	2.11	G	DO													
			High Point Vent and Low Point	2.12	G	DO													
			Drain Pits																
			FRP Containment Sump	2.13	G	DO													
			Liquid Level Gauge	2.14	G	DO													
			Operating Tank Level Switches	2.15	G	DO													
			Lube Oil Dispenser	2.10.3	G	DO													
			SD-07 Certificates																
			System Supplier	1.5	G	RO													
			SD-10 Operation and Maintenance																
			Data																
			Automatic Pump Controls	2.6	G	RO													
			Meters	2.7	G	RO													
			Submersible Pump	2.8.1	G	RO													
			Gear Pump	2.8.3	G	RO													
			Packaged Truck Offload System	2.9	G	RO													
			Filter/Separator	2.11	G	RO													
		33 71 02	SD-03 Product Data																
			Medium Voltage Cable	2.5	G	RO													
			Medium Voltage Cable Joints	2.7	G	RO													

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		33 71 02	Medium Voltage Cable	2.6	G	RO													
			Terminations																
			Precast Concrete Structures	2.12.2.1	G	DO													
			Sealing Material	2.12.2.4															
			Pulling-In Irons	3.5.3															
			Manhole Frames and Covers	2.12.3	G	DO													
			Handhole Frames and Covers	2.12.4	G	DO													
			Composite/Fiberglass Handholes	2.12.6	G	DO													
			Cable Supports	2.13	G	RO													
			SD-06 Test Reports																
			Medium Voltage Cable	2.17.2	G	RO													
			Qualification and Production Tests																
			Field Acceptance Checks and	3.18.1	G	RO													
			Tests																
			Arc-proofing Test	2.17.1	G	RO													
			Cable Installation Plan and	3.3	G	RO													
			Procedure																
			SD-07 Certificates																
			Cable splicer/terminator	1.7.1	G	RO													
			Cable Installer Qualifications	1.7.2	G	RO													
			Certificate of Conformance	1.7.3	G	RO													
		33 82 00	SD-01 Preconstruction Submittals																
			HEMP Protection Subsystem	2.9.1	G	RO													
			(Shielding) Specialist																
			SD-02 Shop Drawings																
			HEMP Measures Shop Drawings	2.9.2	G	RO													

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		33 82 00	Telecommunications Outside	1.6.1.1	G	DO												
			Plant															
			Telecommunications Entrance	1.6.1.2	G	DO												
			Facility Drawings															
			SD-03 Product Data															
			Wire and Cable	2.7	G	DO												
			Cable Splices, and Connectors	2.4	G	DO												
			Closures	2.3	G	DO												
			Spare Parts	1.8.2	G	RO												
			SD-06 Test Reports															
			Pre-installation Tests	3.7.1	G	RO												
			Acceptance Tests	3.7.2	G	RO												
			Outside Plant Test Plan	1.6.3	G	RO												
			SD-07 Certificates															
			Telecommunications Contractor	1.6.2.1	G	RO												
			Key Personnel	1.6.2.2	G	RO												
			Manufacturer's Qualifications	1.6.2.3	G	RO												
			SD-08 Manufacturer’s Instructions															
			Cable Tensions	3.1.8.1	G	RO												
			Fiber Optic Splices	3.1.9.2	G	RO												
			SD-09 Manufacturer’s Field															
			Reports															
			Factory Reel Test Data	2.15.1	G	RO												
			SD-10 Operation and Maintenance															
			Data															

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		33 82 00	Telecommunications Outside	1.6.1.1	G	RO													
			Plant (OSP)																
			SD-11 Closeout Submittals																
			Record Documentation	1.8.1	G	RO													
		41 22 13.14	SD-02 Shop Drawings																
			Overhead Electric Traveling	1.6.4	G	DO													
			Crane																
			Complete Schematic Wiring	3.3.2	G	DO													
			Diagram																
			SD-03 Product Data																
			Gear Reducers	2.3.7.1															
			Hoist Brakes	2.3.10															
			Travel Brakes	2.3.9															
			Load Blocks and Hooks	2.3.3															
			Wheels	2.3.8															
			Hoists	2.3.1	G	DO													
			Sheaves	2.3.5															
			End Trucks	2.2.5															
			Bridge Rails	2.2.3															
			End Stops	2.2.6	G	DO													
			Bumpers	2.2.6															
			Variable Frequency Drives	2.4.2	G	DO													
			Motors	2.4.1	G	DO													
			Runway Conductor System	2.4.8.1	G	DO													
			Bridge Conductor System	2.4.8.2	G	DO													
			Limit Switches	2.4.6	G	DO													

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		41 22 13.14	Pendant Pushbutton Station	2.4.7.1	G	DO												
			Controls	2.4.2	G	DO												
			Control Parameter Settings	3.3.2	G	DO												
			Capacity Overload Protective Device	2.4.9	G	DO												
			Painting System	2.5														
			SD-05 Design Data															
			Load and Sizing Calculations	1.6.5	G	DO												
			SD-06 Test Reports															
			Hook Proof Test	1.6.2.3	G	RO												
			Hook Non-destructive Test (NDT)	1.6.2.2.1	G	RO												
			Post-erection Inspection	3.4.1	G	RO												
			Operational Tests	3.4.2	G	RO												
			Hook Tram Measurement	3.4.4	G	RO												
			Load Tests	3.4.5	G	RO												
			SD-07 Certificates															
			Wire Ropes	1.6.3	G	RO												
			Crane Runway System	1.6.3	G	RO												
			Hazardous Material	1.6.3														
			Loss of Power Test	1.6.3														
			Coupling Alignment Verification Record	1.6.3	G	RO												
			Overload Test	1.6.3	G	RO												
			Brake Adjustment Record	1.6.3	G	RO												
			Compliance with Listed Standards	1.6.3	G	RO												

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION

Power Independence, Mission Control Station - Buckley SFB, CO

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAG # RAPH	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY				MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION		
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		41 22 13.14	SD-10 Operation and Maintenance															
			Data															
			Operation and Maintenance	3.6	G	RO												
			Manuals															
		46 25 14	SD-02 Shop Drawings															
			Separator	1.2.2	G	DO												
			SD-05 Design Data															
			Separator	1.2.2	G	DO												
			SD-06 Test Reports															
			Shop hydrostatic test	2.8.1	G	RO												
			Inspection	3.1														
			Field hydrostatic test	3.3.1														
			Preoperational test	3.3.2														
			In-service test	3.3.3														
			SD-07 Certificates															
			Separator corrosion protection	2.1.1	G	DO												
			SD-08 Manufacturer’s Instructions															
			Separator system	3.2	G	RO												
			SD-10 Operation and Maintenance															
			Data															
			Separator system	3.2	G	RO												

U.S. Army Corps of Engineers (USACE)

TRANSMITTAL OF SHOP DRAWINGS, EQUIPMENT DATA, MATERIAL SAMPLES, OR MANUFACTURER'S CERTIFICATES OF COMPLIANCE

For use of this form, see ER 415-1-10; the proponent agency is CECW-CE.

DATE	TRANSMITTAL NO.

SECTION I - REQUEST FOR APPROVAL OF THE FOLLOWING ITEMS (*This section will be initiated by the contractor*)

TO:	FROM:	CONTRACT NO.	CHECK ONE: ☐ THIS IS A NEW TRANSMITTAL ☐ THIS IS A RESUBMITTAL OF TRANSMITTAL _____

SPECIFICATION SEC. NO. (*Cover only one section with each transmittal*)	PROJECT TITLE AND LOCATION	THIS TRANSMITTAL IS FOR: (*Check one*) ☐ FIO ☐ GA ☐ DA ☐ CR ☐ DA/CR ☐ DA/GA

ITEM NO. (*See Note 3*) a.	DESCRIPTION OF SUBMITTAL ITEM (*Type size, model number/etc.*) b.	SUBMITTAL TYPE CODE (*See Note 8*) c.	NO. OF COPIES d.	CONTRACT DOCUMENT REFERENCE		CONTRACTOR REVIEW CODE g.	VARIATION Enter "Y" if requesting a variation (*See Note 6*) h.	USACE ACTION CODE (*Note 9*) i.
				SPEC. PARA. NO. e.	DRAWING SHEET NO. f.			

REMARKS	I certify that the above submitted items had been reviewed in detail and are correct and in strict conformance with the contract drawings and specifications except as otherwise stated.	
	NAME OF CONTRACTOR	SIGNATURE OF CONTRACTOR

SECTION II - APPROVAL ACTION

ENCLOSURES RETURNED (*List by item No.*)	NAME AND TITLE OF APPROVING AUTHORITY	SIGNATURE OF APPROVING AUTHORITY	DATE

INSTRUCTIONS

1. Section I will be initiated by the Contractor in the required number of copies.

2. Each Transmittal shall be numbered consecutively. The Transmittal Number typically includes two parts separated by a dash (-). The first part is the specification section number. The second part is a sequential number for the submittals under that spec section. If the Transmittal is a resubmittal, then add a decimal point to the end of the original Transmittal Number and begin numbering the resubmittal packages sequentially after the decimal.

3. The "Item No." for each entry on this form will be the same "Item No." as indicated on ENG FORM 4288-R.

4. Submittals requiring expeditious handling will be submitted on a separate ENG Form 4025-R.

5. Items transmitted on each transmittal form will be from the same specification section. Do not combine submittal information from different specification sections in a single transmittal.

6. If the data submitted are intentionally in variance with the contract requirements, indicate a variation in column h, and enter a statement in the Remarks block describing he detailed reason for the variation.

7. ENG Form 4025-R is self-transmitting - a letter of transmittal is not required.

8. When submittal items are transmitted, indicate the "Submittal Type" (*SD-01 through SD-11*) in column c of Section I.
   Submittal types are the following:
   SD-01 - Preconstruction SD-02 - Shop Drawings SD-03 - Product Data SD-04 - Samples SD-05 - Design Data SD-06 - Test Reports
   SD-07 - Certificates SD-08 - Manufacturer's Instructions SD-09 - Manufacturer's Field Reports SD-10 - O&M Data SD-11 - Closeout

9. For each submittal item, the Contractor will assign Submittal Action Codes in column g of Section I. The U.S. Army Corps of Engineers approving authority will assign Submittal Action Codes in column i of Section I. The Submittal Action Codes are:

   A – Approved as submitted.
   B – Approved, except as noted on drawings. Resubmission not required.
   C – Approved, except as noted on drawings. Refer to attached comments. Resubmission required.
   D – Will be returned by separate correspondence.
   E – Disapproved. Refer to attached comments.
   F – Receipt acknowledged.
   X – Receipt acknowledged, does not comply with contract requirements, as noted.
   G – Other action required *(Specify)*
   K – Government concurs with intermediate design. (*For D-B contracts*)
   R – Design submittal is acceptable for release for construction. (*For D-B contracts*)

10. Approval of items does not relieve the contractor from complying with all the requirements of the contract.

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SECTION 01 33 29

SUSTAINABILITY REQUIREMENTS AND REPORTING

02/21

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3.1 HIGH PERFORMANCE AND SUSTAINABLE BUILDING CHECKLIST

-- End of Section Table of Contents --

SECTION 01 33 29

SUSTAINABILITY REQUIREMENTS AND REPORTING
02/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

COUNCIL ON ENVIRONMENTAL QUALITY (CEQ) (WHITE HOUSE)

HPSB Guiding Principles	(2016) Guiding Principles for Sustainable Federal Buildings and Determining Compliance with the Guiding Principles for Sustainable Federal Buildings

INTERNATIONAL CODE COUNCIL (ICC)

ICC IGCC	(2018) International Green Construction Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-200-02	(2020; with Change 1, 2020) High Performance and Sustainable Building Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247	Comprehensive Procurement Guideline for Products Containing Recovered Materials

1.2 SUMMARY

This section includes requirements for Sustainability documentation and reporting submittals per the federally mandated High Performance and Sustainable Building (HPSB) or HPSB "Guiding Principles" (GP), in accordance with Air Force policy and UFC 1-200-02 High Performance and Sustainable Building Requirements. Third-Party Certification does not apply per the exception noted in UFC 1-200-02 paragraph 1.4 of the UFC as the facilities are "unoccupied buildings, which are occupied one hour or less per person per day on average; AND have total building energy consumption (including receptacle and process loads) from all sources less than 12.7 kBTU / SF/ Yr.; AND have annual average water consumption (including process water) of less than 2 gallons per day for the building".

1.3 SUBMITTALS

Government approval is required for submittals with a "G". Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-11 Closeout Submittals

Final High Performance and Sustainable Building Checklist; G, RO

1.4 GUIDING PRINCIPLES VALIDATION (GPV)

Provide the following sustainability activities and documentation to verify achievement of HPSB Guiding Principles Validation (GPV):

a. Analysis of each Guiding Principle Requirement and how project complies. Include final government approved narrative(s) in the HPSB Checklist submittal.

b. No changes to the HPSB Checklist are allowed without approval from the Contracting Officer, in accordance with Section 01 33 00 SUBMITTAL REQUIREMENTS. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved HPSB Guiding Principles requirements for this project. Demonstrate the change will not increase the life-cycle cost and maintains or improves the building performance.

1.5 SUSTAINABILITY SUBMITTALS

Provide HPSB Checklist to indicate compliance with the sustainability requirements of the project.

1.5.1 High Performance Sustainable Building (HPSB) Checklist

Provide the completed HPSB Checklist with the interim DD1354 Real Property Record Submittal.

1.6 DOCUMENTATION REQUIREMENTS

1.6.1 Commissioning (Cx)

Develop and incorporate Commissioning requirements into the documents, in accordance with Section 01 91 00.15 10 TOTAL BUILDING COMMISSIONING.

1.6.2 Indoor Air Quality During Construction

Prior to construction, create indoor air quality plan. Develop and implement an IAQ construction management plan during construction and flush building air before occupancy.

For new construction, meet the requirements of ICC IGCC 1001.3.1.5 (10.3.1.4) Indoor Air Quality (IAQ) Construction Management.

1.6.3 Recycled Content

Comply with 40 CFR 247. Refer to: https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program for assistance identifying products cited in 40 CFR 247. Selected products must comply with non-proprietary requirements of the Federal Acquisition Regulation and must meet performance requirements.

1.6.4 Waste Material Management (Recycling – Construction)

Divert demolition and construction debris in accordance with Section

01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 HIGH PERFORMANCE AND SUSTAINABLE BUILDING CHECKLIST

Submit Final High Performance and Sustainable Building Checklist.

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-- End of Section Table of Contents --

SECTION 01 33 39.00 10

ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS
12/17

PART 1 GENERAL

This project requires delivery of BIM, CIM, GIS, and CAD deliverables during the Design and Construction phases of the project. This specification defines the content and formatting standards by which those deliverables shall conform.

While this specification is not intended to identify all required advanced modeling submittals or deliverables, it defines the content and formatting standards by which those items must conform. See 01 78 24.00 10 FACILITY DATA REQUIREMENTS, and 01 78 39.00 24 AS-BUILT DRAWINGS for deliverable requirements.

All advanced modeling products and deliverables required by this contract shall comply with the applicable provisions herein.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 19005-3	(2012) Document Management -- Electronic Document File Format for Long-Term Preservation -- Part 3: Use of ISO 32000-1 with Support for Embedded Files (PDF/A-3)
ISO 32000-1	(2008) Document Management -- Portable Document Format -- Part 1: PDF 1.7

NATIONAL INSTITUTE OF BUILDING SCIENCES (NIBS)

NBIMS-US	(V3) National BIM Standard - United States
NCS	(V6) United States National CAD Standard

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-1-2909	(2012) Geospatial Data and Systems
ERDC/ITL TR-12-1	(2015) A/E/C Graphics Standard, Release 2.0
ERDC/ITL TR-12-6	(2015) A/E/C CAD Standard - Release 6.0

1.2 DEFINITIONS

1.2.1 Advanced Modeling

A subset of geospatial technologies as defined EM 1110-1-2909 GEOSPATIAL

DATA AND SYSTEMS to include BIM, CIM, GIS, and CAD. Models and drawings that form a digital representation of the project, or part thereof, comprised of "Model Elements" with "Facility/Site Data."

1.2.2 Facility/Site Data

The non-graphical information attached to objects in the Model that defines various characteristics of the object. Facility/Site Data can include properties such as parametric values that drive physical sizes, material definitions and characteristics (e.g. wood, metal), manufacturer data, industry standards (e.g. AISC steel properties), and project identification numbers. Facility/Site Data can also define supplementary physical entities that are not shown graphically in the Model, such as the system of a duct, hardware on a door, content of conduit, or transformer properties.

1.2.3 Model

A digital, graphical or non-graphical, representation of a facility to be used during that facility's lifecycle. A model is composed of model elements and other supporting data to address the intended "model use" or uses.

1.2.4 Model Element

A self-contained element with a unique identification, whose behavior and properties are defined by Facility/Site Data and software processes. Model Elements can represent a physical entity, such as a pump, a concrete wall, or a utility vault and range from the simple to the complex.

1.2.5 Model Uses

Reference NBIMS-US. A Model Use is a method or strategy of applying modeling during a facility's life cycle to achieve one or more specific objectives.

1.2.6 Record Model

A model reflecting all approved changes during construction including red-lines, requests for information (RFIs), and contract modifications. Includes updated construction phase facility/site data for all components.

1.2.7 USACE BIM/CIM Platform Configuration Standards - Templates, Workspaces, Catalogs, and Environments

a. A/E/C Work Structure:

A common environment that can be used across agencies and engineering applications. This environment contains folder structures, tools, and resource files that implement the A/E/C CAD Standard and the A/E/C Graphics Standard documents.

b. Bentley AECOsim and InRoads Workspace:

The Workspace is contained within the A/E/C Work Structure. It is comprised of a collection of content libraries and supporting files that define and embody a BIM standard. Libraries include content such as wall types, standard steel shapes, furniture, HVAC fittings, and sprinkler heads. The Workspace also contains sheet

libraries such as print/plot configurations, font and text style libraries, and sheet borders and title blocks. The Workspace includes pre-defined datagroup parameters.

c. USACE Revit Templates:

The USACE has developed Revit Templates specific to USACE BIM standards; these templates are Revit version specific. The USACE Revit templates are discipline specific and include family content pertinent to that discipline. The Templates share standard symbology such as annotation families, line styles, and text styles. The Templates include pre-defined shared parameters.

1.2.8 USACE CAD/BIM Technology Center

The USACE CAD/BIM Technology Center hosts all standard advanced modeling content for USACE. This content can be accessed through the CAD/BIM Technology Center website, https://cadbimcenter.erdc.dren.mil/.

1.2.9 Working Construction Model

Working model created and updated during construction which incorporate the changes received during construction to including red-lines, requests for information (RFIs), and contract modifications at intervals during the construction process. These include updated construction phase facility/site data for installed components.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Advanced Modeling Project Execution Plan (PxP) G, DO

PxP Demonstration; G, RO

1.4 QUALITY ASSURANCE

1.4.1 Advanced Modeling Project Execution Plan (PxP)

Develop an Advanced Modeling Project Execution Plan ("Plan" or "PxP") documenting mandatory and Contractor-elected BIM Uses, analysis technologies, and workflows.

Submit the PxP within forty-five (45) days after Notice to Proceed.

Contractors shall use the USACE ADVANCED MODELING (BIM) PROJECT EXECUTION PLAN (PxP) Template located at the USACE CAD/BIM Technology Center website to develop an acceptable plan to include platforms and processes.

1.4.1.1 Minimum Modeling Matrix (M3)

The USACE Minimum Modeling Matrix (M3) describes the minimum modeling and data requirements by defining the Level of Development ("LOD") and Element

Grade. Contractors shall use the M3 Template located at https://cadbimcenter.erdc.dren.mil/ and submit as part of the PxP.

Per instructions in the M3, Contractor is to identify elements included in the project scope and provide any applicable comments

1.4.1.2 Advanced Modeling PxP as Living Document

The Contractor shall maintain the PxP to reflect advanced modeling practices, procedures, and methods of compliance throughout the duration of the Project. Resubmit the PxP to the Government for approval if changes alter method of contract compliance. Updates and revisions to the PxP that do not significantly alter contents and/or method of compliance need not be submitted for approval.

1.4.1.3 Model Uses

Include all of the following Model Uses in the PxP.

1.4.1.3.1 Mandatory Model Uses

The following Model Uses are mandatory:

1.4.1.3.1.1 Design Phase Mandatory Model Uses

a. Design Authoring
b. 3D Coordination
c. Progress Review

1.4.1.3.1.2 Construction Phase Mandatory Model Uses

a. 3D Coordination
b. Record Modeling

1.4.1.3.2 Optional Model Uses

Contractor may use or pursue other Model Uses as desired. Also document these uses in the PxP.

1.4.2 PxP Demonstration

See PxP Demonstration meeting requirements described in "Meetings" paragraph below.

1.4.3 Meetings

1.4.3.1 Post-Award Kickoff Meeting

At minimum discuss the following during the meeting:

a. The requirement for Advanced Modeling deliverables under this Contract.

b. Primary roles and responsibilities associated with the development and delivery of the Advanced Modeling submittals under this Contract.

c. Identify and agree upon a date and attendance list for the meetings described below:

1.4.3.2 Advanced Modeling Kick-Off Meeting

Conduct an Advanced Modeling Kick-Off Meeting prior to submission of the PxP, within forty-five (45) days after Notice to Proceed. This meeting must include, at a minimum, the Contractor and the Geographic District BIM Manager or delegate.

The intent of this meeting is to coordinate the Government's and the Contractor's expectations for the Advanced Modeling PxP.

1.4.3.3 PxP Demonstration Meeting

Within thirty (30) days after the acceptance of the PxP and M3, conduct a demonstration to review the Plan for clarification, and to verify the functionality of planned Model technology workflow and processes. If modifications are required, the Contractor shall complete the modifications and resubmit the PxP performing a subsequent demonstration for Government acceptance. There will be no payment for design or construction until the PxP is completed and accepted by the Government. The Government may also withhold payment for unacceptable performance in executing the accepted PxP.

1.5 OWNERSHIP AND RIGHTS OF DATA

The Government has ownership of and rights at the date of Closeout Submittal to all CAD files, BIM/CIM Model(s), and Facility/Site Data developed for the Project in accordance with FAR Part 27, clauses incorporated in Section 00 72 00, GENERAL CONDITIONS (Contract Clauses - RFP) and Section 00 73 00 SPECIAL CONDITIONS Special Contract Requirement 1.14 GOVERNMENT RE-USE OF DESIGN. The Government may make use of this data following any deliverable.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver Advanced Modeling submittals in an organized and legible manner. Provide submittals adhering to the requirements described below.

1.6.1 Advanced Modeling Submittal Packaging

When a project specification requires advanced modeling deliverables, provide the following documents and files in support of those advanced modeling deliverables. Submission of items listed below shall not limit compliance with deliverable and submittal requirements in those respective specifications. Submit all advanced modeling deliverables electronically, media and/or method as indicated in this Contract. Provide number of copies of electronic media (if required) as described below:

1.6.1.1 Approved PxP

Provide an electronic copy of the most current approved version of the project Advanced Modeling PxP.

1.6.1.2 List of Submitted Files

Provide an electronic list (.txt file or similar) of all submitted electronic files including a description, directory, and file name for each file submitted. Identify which files have been produced from the Model and Facility Data. For all Sheet files, include a list of the sheet titles and sheet numbers.

1.6.1.3 Advanced Modeling Submittal Checklist

Complete the USACE BIM/CIM Advanced Modeling Submittal Checklist and include with each submittal. Download the Checklist from the USACE CAD/BIM Technology Center website.

1.6.1.4 Advanced Modeling Electronic Files

Provide all native advanced modeling files associated with the production of the advanced modeling deliverable. Update and maintain in compliance with the advanced modeling formatting, content requirements, and standards as defined by this specification, in order to yield a complete and coordinated document set.

1.6.1.5 Facility Data Deliverables

Provide all electronic facility data deliverables in the format(s) described in this and referenced specification(s).

1.6.1.6 Interactive Review Model

A copy of each BIM and CIM Model in the approved interactive review format.

1.6.1.7 CAD Exports of BIM-Generated Sheets and Drawings

Provide supplemental 2D CAD exports of all contract drawing sheets from the project BIM model. Export all contract drawing sheets to the CAD format(s) defined in this specification.

1.6.1.8 GeoDataBase Files

Provide a SDSFIE/FGDC GeoReferenced personal GeoDataBase.

For all information outside of the building walls, the Contractor shall provide a personal GeoDatabase in .mdb format using the latest version of Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) as the database structure. Provide a shell database to define the projection and database structure.

For all drawings within and including the exterior walls, the Contractor shall utilize the advanced modeling formats described and referenced herein.

Provide a short GeoDataBase read-me file explaining the deliverable. The read-me file shall include a description of the software used to create the data, projection, and include the attribute tables used.

1.6.1.9 QC Reports

Provide electronic PDFs of all QC reports and checks utilized to ensure full compliance with the contract requirements and standards:

1.6.1.9.1 Model Standards Checks and Reports

Provide QC checks demonstrating adherence to the NCS "BIM Implementation" section. Verify that the Project Facility/Site Data set has no undefined, incorrectly defined or duplicated elements. Identify and report non-compliant elements and submit a corrective action plan. Provide the

Government with detailed justification and request Government acceptance for any non-compliant element that the Contractor proposes to be allowed to remain in the Model.

a. No errors when opening.

b. No broken Links, References, or X-References.

c. Minimized extraneous information.

d. Content uses the coordinate system defined in the approved PxP.

e. Models share a common alignment point.

f. Each discipline identified in the approved PxP is represented.

1.6.1.9.2 Other Parameters

Develop such other QC parameters as Contractor deems appropriate for the Project and provide to the Government for acceptance

1.6.1.10 PDF Documents

Provide one PDF file of design documents per discipline and one additional PDF file combining all disciplines, following the A/E/C CAD Standard discipline and drawing order. Bookmark PDF files in compliance with bookmarking requirements described in 01 78 24.00 10 FACILITY DATA REQUIREMENTS.

1.6.1.11 Advanced Modeling Re-Submittals

If components of an as-built submittal are rejected, provide the following for each re-submittal, in addition to information required by 01 33 00 SUBMITTAL PROCEDURES:

a. Re-submit all components required under paragraph ADVANCED MODELING SUBMITTAL PACKAGING, including a new Advanced Modeling Checklist and updated content in response to Government comments.

b. Provide a copy of all Government review comments.

c. Provide a response to each Government review comment for back check.

1.6.2 Malicious Content

Scan all files for malicious viruses using commercially available scanning program that is routinely updated to identify and remove current virus threats.

1.6.3 Protection of GIS Data

GIS source data and product data remain the property of the US Government. The contractor may be required to explain and demonstrate the company's process for protecting all geospatial data, including but not limited to geometry, attributes, metadata, topologies, and relational database schemas and operations used in association with this contract. The contractor may be required to sign a non-disclosure agreement attesting to

the same before source data are released. Further information about security and nondisclosure requirements should be obtained from the COR. Some installation map data, source and/or product, may be considered by the government to be "Controlled Unclassified Information" (CUI) also known as "Sensitive but Unclassified" (SBU). The contractor is not authorized to release this information to any third party without the explicit consent of the COR. All source information must be returned to the Government or destroyed upon completion of this contract.

PART 2 PRODUCTS

2.1 GOVERNMENT FURNISHED MATERIALS

The Government will provide advanced modeling bridging files for the Contractor's use in developing the project Design. Such Government Furnished Material (GFM) is conceptual and is issued for information only. Quality of GFM shall not limit compliance with deliverable and quality requirements described herein.

The Contractor has the option of preparing their own BIM/CIM models and CAD drawings in lieu of utilizing GFM. Such drawings and models will also be held to the deliverable and quality requirements described herein.

2.1.1 GFM Handover

The Government will provide the GFM at the Advanced Modeling Kick-Off Meeting.

The Contractor is responsible for reviewing the GFM and, if the Contractor chooses to use the GFM, updating the files to meet the standards required by this specification.

2.1.2 GFM File Formats

GFM will be provided in the following file formats:

2.1.2.1 Government Furnished BIM

The GFM will include Autodesk Revit 2016 files.

2.1.2.2 Government Furnished CIM

The GFM will include Autodesk Civil 3D files within the Bentley AECOsim and InRoads Workspace.

2.1.2.3 Government Furnished CAD

The GFM will include Autodesk AutoCAD 2013 files within the Bentley AECOsim and InRoads Workspace.

2.1.3 Variation with Contract Drawings

The Government makes no claim or warranty that any of the GFM are complete or fully consistent with the contract drawings. The digital files provided are not part of the contract documents. If there is any discrepancy between the BIM/CIM models, the CAD drawings, and the contract drawings, the contract drawings shall govern. The Government has no responsibility to modify any GFMs due to changes in the design that occur after award, and the Government shall assume no liability for the contents of the files

provided.

Evaluate the content and quality of the GFM upon receipt. If major discrepancies or omissions occur in the GFM, notify the Contracting Officer and indicate the nature of such variation(s).

2.1.4 Model Completion and Quality for Bridging Files

The Government makes no guarantee that the bridging GFM files are developed to the level of completeness or quality required for submittals described herein. It is the Contractor's responsibility to develop the design design (and associated files) in compliance with requirements described herein.

2.1.5 Data Loss, Corruption, and Error

Transfer of GFM files to the Contractor may result in corrupted files resulting in data loss and/or errors. Use of GFM files is at the Contractor's risk. Verify data integrity upon receipt and request a replacement if necessary.

Any adjustment of file structure, format, or software version required to make GFM compatible with the Contractor's computer systems and/or software is the responsibility of the Contractor.

2.2 SYSTEM PLATFORM AND FILE FORMATS

The Contractor shall use the BIM, CIM, GIS, and CAD application(s), software(s), and file format(s) described below:

2.2.1 BIM

The BIM submittal format shall be Autodesk Revit 2016 or newer. The BIM submittals shall be fully operable, compatible, and editable within the native BIM/CIM tools.

2.2.2 CAD Exports of BIM-Generated Sheets and Drawings

Provide supplemental 2D CAD exports from the project BIM model. Export all contract drawing sheets in Autodesk AutoCAD 2013 or newer.

2.2.3 CIM

The CIM submittal format shall be Autodesk Civil 3D 2013 or newer. The CIM submittals shall be fully operable, compatible, and editable within the native BIM/CIM tools.

2.2.4 GIS

All GIS databases shall be submitted in Environment Systems Research Institute's (ESRI) ArcGIS Personal Geodatabase.

2.2.5 CAD

Any CAD files shall be Autodesk AutoCAD 2013 or newer.

2.2.6 Facility Data Requirements

This contract contains requirements for collection, organization, and

turnover of electronic Facility Data deliverables. Provide Facility Data under the the following content and formatting standards:

2.2.6.1 Facility Data Workbook (FDW)

Provide complete Facility Data Workbook(s) and Facility Document Set(s) in compliance with 01 78 24.00 10 FACILITY DATA REQUIREMENTS.

Coordinate Facility Data requirements with Advanced Modeling requirements and document in the Advanced Modeling PxP as appropriate.

2.2.7 Other Formats

2.2.7.1 Interactive Review Model

The 3D Interactive Review Model format shall be Autodesk Navisworks 2016 or newer.

2.2.7.2 PDF

Utilize PDF file format in accordance with ISO 32000-1 and ISO 19005-3. Provide files from original sources, text-searchable, and saved in "Standard" (uncompressed) resolution whenever possible.

PART 3 EXECUTION

3.1 ADVANCED MODELING REQUIREMENTS

3.1.1 BIM and CIM

All BIM and CIM content authoring, model coordination, content delivery and all other activities and products shall comply with the NCS BIM Implementation section, part "3.0 Basic BIM Guidelines."

All CAD content produced within the BIM and CIM authoring platforms shall comply with the NCS BIM Implementation section, part "2.0 Clarifications."

3.1.1.1 Minimum Modeling Requirements

Model to the requirements of the USACE Minimum Modeling Matrix(M3).

3.1.1.2 USACE Software Configuration Standards

a. Develop the project using the A/E/C Workstructure, version contained in GFM.

b. Develop the project using USACE Revit Templates (Most recent version at the time of Contract award). Download from the USACE CAD/BIM Technology Center website and, if required, upgrade to the Contract approved software version.

3.1.1.3 Classification

All modeled elements shall include Facility/Site Data referencing one or more classification system(s) identified in the M3.

3.1.1.4 Space/Room Data

The Model shall include spatial data defining actual net square footage

and data to develop the room finish schedule, including room names and numbers. Include program information to verify design space against programmed space, using this information to validate area quantities.

3.1.1.5 CIM Coordinate System

a. Colorado State Plane Coordinate System: 83

3.1.1.6 Schedules

Schedules shall comply with the NCS BIM Implementation section, part "2.4 Schedules." Schedules shall be produced from, and remain linked to, the Facility/Site Data within the Model. Any exceptions must be documented in the PxP and submitted to the Geographic BIM Manager, or delegate, for review.

3.1.1.7 Details and Enlarged Sections

Details and enlarged sections shall comply with the NCS BIM Implementation section, part "3.2 Model Coordination and Delivery." All details and enlarged sections necessary for construction shall be derived from the Model when possible. For those details and enlarged sections not derived directly from the Model, Contractor must verify that geometry and data depicting the details and enlarged sections are consistent with Model elements. Details with significant drafted content such as 'standard' and 'typical' details shall not contradict the model and shall utilize the model as an underlay when possible for the purposes of verification and coordination. Three dimensional, isometric, and section isometric details derived from the model are preferred. Details and enlarged sections that are not derived from the Model must created using native authoring tools within the Model or be embedded within the Model.

3.1.1.8 Drawing Indices

Drawing indices shall comply with the NCS BIM Implementation section, part "2.3 Sheet Organization." Where BIM authoring platform supports it, drawing indices should be derived from a model-driven schedule.

3.1.1.9 CAD Export

CAD content exported form a BIM or CIM modeling platform shall comply with the NCS BIM Implementation section, part "2.0 Clarifications."

CAD file format and version shall be as indicated in the "CAD" paragraph below.

3.1.2 GIS

3.1.2.1 Minimum Modeling Requirements

Provide final geo-referenced GIS database of the new building footprint, and site surface and subsurface features that exist outside the building footprint(s) out to the project extents.

Contractor shall collect GIS geo-referenced data pertaining to location and attribute data of subsurface utilities obtained at the time of project site excavation. All data collection for underground utilities shall include the collection of elevation (Z) values.

3.1.2.2 Standard GIS Database Template

The Contractor must use the Standard GIS Database Template provided by Installation Geospatial Support Office to produce the GIS deliverables required under this contract.

3.1.3 CAD

All CAD content produced through native CAD authoring software outside of any BIM or CIM platform shall be compliant with ERDC/ITL TR-12-6 A/E/C CAD Standard and ERDC/ITL TR-12-1 A/E/C Graphic Standard.

3.1.3.1 USACE Software Standards

a. Autodesk AutoCAD Template Files Most recent version at the time of Contract award. Download form the CAD/BIM Technology Center website as part of the A/E/C Work Structure.

3.2 FINAL DESIGN AND FINAL RECORD SUBMITTAL REQUIREMENTS

Follow requirements for Content Delivery from the NCS BIM Implementation section, part "3.0 Basic BIM Guidelines."

3.3 AS-BUILT ADVANCED MODELING REQUIREMENTS

See Section 01 78 39.00.24 AS-BUILT DRAWINGS for additional as-built and record model quality and deliverable requirements. Deliverable requirements listed in that specification shall not preclude development of the project in BIM/CIM/GIS/CAD through construction as required herein.

3.4 WAIVERS OF SPECIFIC REQUIREMENTS

If a requirement contained in this document can not be achieved, or can not be achieved at a cost commensurate with the value of the requirement, the Contractor may request, in writing, that the requirement be withdrawn or modified. The request must certify that the Contractor has diligently attempted to meet the requirement, that the requirement can not reasonably be met, and that alternative approaches meet the intent of the requirement. The request must be supported by evidence of the Contractor's research and documentation that the alternative approach meets the function and interoperability requirements of this document. The Government, in its sole discretion, may waive requirements found to be currently unachievable or not commercially practicable.

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GOVERNMENTAL SAFETY REQUIREMENTS
OMA 05/24, CHG 1: 05/25

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2017) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ANSI/ASSP A10.34	(2021) Protection of the Public on or Adjacent to Construction Sites
ANSI/ASSP A10.44	(2020) Control of Energy Sources (Lockout/Tagout) for Construction and Demolition Operations

ASTM INTERNATIONAL (ASTM)

ASTM D6245	(2012) Using Indoor Carbon Dioxide Concentrations to Evaluate Indoor Air Quality and Ventilation
ASTM D6345	(2010) Standard Guide for Selection of Methods for Active, Integrative Sampling of Volatile Organic Compounds in Air
ASTM F855	(2020) Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1048	(2016) Guide for Protective Grounding of Power Lines
IEEE C2	(2023) National Electrical Safety Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z89.1	(2014; R 2019) American National Standard for Industrial Head Protection

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 51B	(2024) Standard for Fire Prevention During Welding, Cutting, and Other Hot Work
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace
NFPA 241	(2022) Standard for Safeguarding Construction, Alteration, and Demolition Operations
NFPA 306	(2024) Standard for the Control of Gas Hazards on Vessels

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

ANSI/SMACNA 008	(2007) IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 20	Standards for Protection Against Radiation
29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1915	Confined and Enclosed Spaces and Other Dangerous Atmospheres in Shipyard Employment
29 CFR 1926	Safety and Health Regulations for Construction
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
CPL 2.100	(1995) Application of the Permit-Required Confined Spaces (PRCS) Standards, 29 CFR 1910.146

1.2 DEFINITIONS

The following definitions are for the convenience of the reader. If there is a referenced document in the text of this specification section, that is the document that should define terms for that paragraph. If further clarification is needed, contact the Contracting Officer.

1.2.1 Site Safety and Health Officer (SSHO)

A Contractor Employee that is responsible for overseeing and ensuring

implementation of the prime Contractor's Safety and Occupational Health (SOH) program according to the Contract, EM 385-1-1, applicable federal, state, and local requirements.

1.2.1.1 Level One SSHO

A designated employee with full-time SOH responsibility that meets and follows the requirements of EM 385-1-1.

1.2.1.2 Level Two SSHO

A designated employee with Level Two SSHO responsibility that meets and follows the requirements of EM 385-1-1. Level Two SSHOs cannot be assigned to projects that have a residual Risk Assessment Code (RAC) of high or extremely high.

1.2.1.3 Level Three SSHO

A designated Qualified Person or Competent Person with SOH responsibility that meets and follows the requirements of EM 385-1-1. Level 3 SSHOs cannot be assigned to projects that have a residual RAC of high or extremely high.

1.2.1.4 Alternate SSHO

An employee that meets the definition of the contract-required level SSHO, but is not the primary SSHO.

1.2.2 Competent Person (CP)

The CP is a person designated in writing, who, through training, knowledge and experience, is capable of identifying, evaluating, and addressing existing and predictable hazards in the working environment or working conditions that are unsanitary, hazardous, or dangerous to personnel, and who has authorization to take prompt corrective measures to eliminate them.

1.2.3 Qualified Person (QP)

The QP is a person designated in writing, who, by possession of a recognized degree, certificate, or professional standing, or extensive knowledge, training, and experience, has successfully demonstrated their ability to solve or resolve problems related to the subject matter, the work, or the project.

1.3 SUBMITTALS

Government Acceptance or Approval does not remove responsibility from the Contractors for their actions or liability.

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Accident Prevention Plan (APP); G, RO

Indoor Air Quality (IAQ) Management Plan; G, RO

SD-06 Test Reports

Accident Reports; G, RO

LHE Inspection Reports

Monthly Exposure Reports; G, RO

SD-07 Certificates

Activity Hazard Analysis (AHA); G, RO

Certificate of Compliance

Hot Work Permit

License Certificates

Portable Gauge Operations Planning Worksheet; G, RO

Radiography Operation Planning Work Sheet; G, RO

Standard Lift Plan; G, RO

Critical Lift Plan; G, RO

1.4 PUBLIC HEALTH EMERGENCIES

In the event of a declared public health emergency, follow safety precautions as required by the Occupational Safety and Health Administration (OSHA) www.osha.gov, the Centers for Disease Control and Prevention (CDC) www.cdc.gov, and as required by federal, state and local requirements.

1.5 MONTHLY EXPOSURE REPORTS

Provide a Monthly Exposure Report by the fifth day of each month for the previous month. This report is a compilation of employee-hours worked each month for all site workers, both Prime and subcontractor. Failure to submit the report may result in retention of up to 10 percent of the progress payment. Submit the hours via the agency construction management system of record.

1.6 REGULATORY REQUIREMENTS

In addition to the detailed requirements included in the provisions of this Contract, comply with the most recent edition of USACE EM 385-1-1, and the following federal, state, and local laws, ordinances, criteria, rules and regulations at the date of the Solicitation for this Contract. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting work. Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements govern.

1.7 SITE QUALIFICATIONS, DUTIES, AND MEETINGS

1.7.1 Site Safety and Health Officer (SSHO)

1.7.1.1 Qualifications of SSHO

All SSHOs will have met the training, experience requirements identified in the EM 385-1-1 and this Contract.

1.7.1.2 Duties of SSHO

All SSHOs will carry out the roles and responsibilities as identified in this Contract and the EM 385-1-1. All SSHOs will be designated on an ENG Form 6282, provided by the Contracting Officer. Superintendent, QC Manager, and SSHO are subject to dismissal if their required duties are not being effectively carried out. If either the Superintendent, QC Manager, or SSHO are dismissed, project work will be stopped and will not be allowed to resume until a suitable replacement is approved and the above duties are again being effectively carried out.

1.7.1.3 Safety Meetings

Conduct safety meetings to review past activities, plan for new or changed operations, review pertinent aspects of appropriate AHA (by trade), establish safe working procedures for anticipated hazards, and provide pertinent Safety and Occupational Health (SOH) training and motivation. Conduct meetings at least once a month for all supervisors at the project location. The SSHO, supervisors, or foremen must conduct meetings at least once a week for the trade workers. Document meeting minutes to include the date, persons in attendance, subjects discussed, and names of individual(s) who conducted the meeting. Maintain documentation on-site and furnish copies to the Contracting Officer on request. Notify the Contracting Officer of all scheduled meetings 7 calendar days in advance.

1.7.2 Roles and Responsibilities of Prime Contractor and SSHO

The Prime Contractor and SSHO must ensure that the requirements of all applicable OSHA and EM 385-1-1 are met for the project. The Prime Contractor must ensure an SSHO or an equally qualified Alternate SSHO(s) is at the worksite at all times to implement and administer the Contractor's safety program and Government accepted Accident Prevention Plan. "Worksite" is defined as the physical location of construction activities. If the required SSHO has to temporarily (that is, up to 24 hours / 1 day) leave the site of work due to unforeseen or emergency situations, a Level One, Two, or Three SSHO may be used in the interim and must be on the site of work at all times when work is being performed.

If the SSHO must be off-site for a period longer than 24 hours / 1 day, a qualified alternate that meets the contract requirements must be onsite.

a. Prime contractor must ensure all SSHOs:

(1) Are designated on an ENG Form 6282.

(2) Meet minimum training and experience requirements identified in EM 385-1-1.

(3) Execute roles and responsibilities identified in EM 385-1-1.

1.7.3 Contract Site Safety And Health Officer(s)(SSHOs) Minimum Requirements

Provide a minimum of one Level One SSHO that meets the requirements of EM 385-1-1 for this project.

1.7.4 Competent Person for Confined Space Entry

Provide a CP for Confined Space Entry who meets the requirements of EM 385-1-1 and herein. The CP for Confined Space Entry must supervise the entry into each confined space in accordance with EM 385-1-1.

Since this work involves operations that handle combustible or hazardous materials, this person must have the ability to understand and follow through on the air sampling, Personal Protective Equipment (PPE), and instructions of a Marine Chemist, Coast Guard authorized persons, or Certified Industrial Hygienist. Confined space and enclosed space work must comply with NFPA 306, 29 CFR 1915, "Confined and Enclosed Spaces and Other Dangerous Atmospheres in Shipyard Employment," or as applicable in 29 CFR 1910 for general industry, 29 CFR 1926 for construction.

1.7.5 Preconstruction Conference

a. Contractor representatives who have a responsibility or significant role in accident prevention on the project must attend the preconstruction conference. This includes the project superintendent, Site Safety and Occupational Health Officer, quality control manager, or any other assigned safety and health professionals who participated in the development of the APP (including the Activity Hazard Analyses (AHAs) and special plans, program and procedures associated with it).

b. Discuss the details of the submitted APP to include incorporated plans, programs, procedures and a listing of anticipated AHAs that will be developed and implemented during the performance of the Contract. This list of proposed AHAs will be reviewed and an agreement will be reached between the Contractor and the Contracting Officer as to which phases will require an analysis. In addition, establish a schedule for the preparation, submittal, and Government review of AHAs to preclude project delays. The creation of the APP and Schedule will be created after being given Notice to Proceed.

c. Deficiencies in the submitted APP, identified during the Contracting Officer's review, must be corrected, and the APP re-submitted for review prior to the start of construction. Work is not permitted to begin until an APP is established that is acceptable to the Contracting Officer.

1.8 ACCIDENT PREVENTION PLAN (APP)

1.8.1 Accident Prevention Plan (APP)

Submit the Accident Prevention Plan (APP) for review and acceptance by the Government at least 15 calendar days prior to the start, after being given Notice to Proceed. A competent person must prepare the written site-specific APP. Prepare the APP in accordance with the format and requirements of EM 385-1-1, ENG Form 6293, and herein. The APP must be job-specific and address any unusual or unique aspects of the project or activity for which it is written. The APP must interface with the Contractor's overall safety and occupational health program referenced in

the APP in the applicable APP element, and made site-specific. Describe the methods to evaluate past safety performance of potential subcontractors in the selection process. Also, describe innovative methods used to ensure and monitor safe work practices of subcontractors. The Government considers the Prime Contractor to be the "controlling employer" for all worksite safety and health of the subcontractors. Contractors are responsible for informing their subcontractors of the safety provisions under the terms of the Contract and the penalties for noncompliance, coordinating the work to prevent one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting subcontractor operations to ensure that accident prevention responsibilities are being carried out. The APP must be signed in accordance with the APP and ENG Form 6293 Accident Prevention Plan Worksheet. The SSHO must provide and maintain the APP and a log of signatures by each subcontractor foreman, attesting that they have read and understand the APP, and make the APP and log available on-site to the Contracting Officer. If English is not the foreman's primary language, the Prime Contractor must provide an interpreter.

Submit the APP to the Contracting Officer 15 calendar days prior to the date of the preconstruction conference for acceptance. Work cannot proceed without an accepted APP. Once reviewed and accepted by the Contracting Officer, the APP and attachments will be enforced as part of the Contract. Disregarding the provisions of this Contract or the accepted APP is cause for stopping of work, at the discretion of the Contracting Officer, until the matter has been rectified. Continuously review and amend the APP, as necessary, throughout the life of the Contract. Changes to the accepted APP must be made with the knowledge and concurrence of the Contracting Officer, project superintendent, SSHO and Quality Control Manager. Incorporate unusual or high-hazard activities not identified in the original APP as they are discovered. Should any severe hazard exposure (i.e., imminent danger) become evident, stop work in the area, secure the area, and develop a plan to remove the exposure and control the hazard. Notify the Contracting Officer within 24 hours of discovery. Eliminate and remove the hazard. In the interim, take all necessary action to restore and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public (as defined by ANSI/ASSP A10.34), and the environment.

1.8.2 Names and Qualifications

Provide plans in accordance with the requirements outlined in EM 385-1-1, including the following:

a. Names and qualifications (resumes including education, training, experience and certifications) of site safety and health personnel designated to perform work on this project to include the designated Site Safety and Health Officer and other competent and qualified personnel to be used. Specify the duties of each position.

b. As a minimum, designate and submit qualifications of Competent Persons (CP) for each of the following major areas: excavation; scaffolding; fall protection; hazardous energy; confined space; health hazard recognition, evaluation and control of chemical, physical and biological agents; and personal protective equipment and clothing to include selection, use and maintenance. Designate and submit qualifications for additional CPs as applicable to the work performed under this Contract.

1.8.3 Plans

Provide plans in the APP in accordance with the requirements outlined in EM 385-1-1, including the following:

1.8.3.1 Lead, Cadmium, and Chromium Compliance Plan

Identify the safety and health aspects of work involving lead, cadmium and chromium, and prepare in accordance with Section 02 83 00 LEAD REMEDIATION.

1.8.3.2 Asbestos Hazard Abatement Plan

Identify the safety and health aspects of asbestos work, and prepare in accordance with Section 02 82 00 ASBESTOS REMEDIATION.

1.8.3.3 Polychlorinated Biphenyls (PCB) Plan

Identify the safety and health aspects of Polychlorinated Biphenyls work, and prepare in accordance with Section 02 84 16 HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBs AND MERCURY.

1.8.3.4 Site Demolition Plan

Identify the safety and health aspects, and prepare in accordance with Section 02 41 00 DEMOLITION AND DECONSTRUCTION and referenced sources.

1.9 ACTIVITY HAZARD ANALYSIS (AHA)

Before beginning each activity, task or Definable Feature of Work (DFOW) involving a type of work presenting hazards not experienced in previous project operations, or where a new work crew or subcontractor is to perform the work, the Contractor(s) performing that work activity must prepare an AHA. AHAs must be developed by the Prime Contractor, subcontractor, or supplier performing the work, and provided for Prime Contractor review and approval before submitting to the Contracting Officer. AHAs must be signed by the SSHO, Superintendent, QC Manager and the subcontractor Foreman performing the work. Format the AHA in accordance with EM 385-1-1 or as directed by the Contracting Officer. Submit the AHA for review at least 15 working days prior to the start of each activity task, or DFOW. The Government reserves the right to require the Contractor to revise and resubmit the AHA if it fails to effectively identify the work sequences, specific anticipated hazards, site conditions, equipment, materials, personnel and the control measures to be implemented.

AHAs must identify competent persons required for phases involving high risk activities, including confined entry, crane and rigging, excavations, trenching, electrical work, fall protection, and scaffolding.

1.9.1 AHA Management

Review the AHA list periodically (at least monthly) at the Contractor supervisory safety meeting, and update as necessary when procedures, scheduling, or hazards change. Use the AHA during daily inspections by the SSHO to ensure the implementation and effectiveness of the required safety and health controls for that work activity.

1.9.2 AHA Signature Log

Each employee performing work as part of an activity, task or DFOW must review the AHA for that work and sign a signature log specifically maintained for that AHA prior to starting work on that activity. The SSHO must maintain a signature log on site for every AHA. Provide employees whose primary language is other than English, with an interpreter to ensure a clear understanding of the AHA and its contents.

1.10 SITE SAFETY REFERENCE MATERIALS

Maintain safety-related references applicable to the project, including those listed in paragraph REFERENCES. Maintain applicable equipment manufacturer's manuals.

1.11 EMERGENCY MEDICAL TREATMENT

Contractors must arrange for their own emergency medical treatment in accordance with EM 385-1-1. The Government has no responsibility to provide emergency medical treatment.

1.12 NOTIFICATIONS AND REPORTS

1.12.1 Accident Notification

Notify the Contracting Officer in accordance with the EM 385-1-1 Accident Reporting Timeline.

Table
Accident Reporting Required Timeline

Accident Type	Notify KO or COR	Complete Final Accident Report on ENG 3394 and provide to KO or COR
Fatality, in-patient hospitalization, amputation, eye loss, or property damage over $600,000.	Immediately, no later than (NLT) 8 Hours	Within 7 Days
All other accidents and near misses	Immediately, no later than (NLT) 24 Hours	Within 7 Days

Within notification include Contractor name; Contract title; type of Contract; name of activity, installation or location where accident occurred; date and time of accident; names of personnel injured; extent of property damage, if any; extent of injury, if known, and brief description of accident (for example, type of construction equipment used and PPE used). Preserve the conditions and evidence on the accident site until the Government investigation team arrives on-site and Government investigation is conducted. Assist and cooperate fully with the Government's investigation(s) of any accident or near miss.

1.12.2 Accident Reports

a. Conduct an accident investigation for recordable injuries and

illnesses, property damage, and near misses as defined in EM 385-1-1, to establish the root cause(s) of the accident. All accidents are reportable, regardless of whether or not it is recordable. Complete the applicable USACE Accident Report, ENG Form 3394, and provide the report to the Contracting Officer within 7 calendar days of the accident. The Contracting Officer will provide copies of any required or special forms. All accidents are reportable, regardless of whether or not it is recordable.

b. Near Misses: For Army projects, report all "Near Misses" to the Contracting Officer, using local accident reporting procedures, within 24 hours. The Contracting Officer will provide the Contractor the required forms. Near miss reports are considered positive and proactive Contractor safety management actions.

1.12.3 LHE Inspection Reports

Submit LHE inspection reports required in accordance with EM 385-1-1 and as specified herein with Daily Reports of Inspections.

1.12.4 Certificate of Compliance and Pre-lift Plan/Checklist for LHE and Rigging

Provide a Certificate of Compliance for LHE entering an activity under this Contract and in accordance with EM 385-1-1. Post certifications on the crane.

Develop a Standard Lift Plan (SLP) or Critical Lift Plan (CLP) in accordance with EM 385-1-1. Utilize the Standard Lift Plan ENG Form 6203 for routine crane lifts and use the Critical Lift Plan ENR Form 6213 for non-routine crane lifts requiring more detailed planning and additional safety precautions, as defined by Section 16-2j of the EM 385-1-1. Submit lift plans to the Contracting Officer for approval within 15 calendar days in advance of planned lift.

1.13 HOT WORK PERMIT

1.13.1 Permit and Personnel Requirements

Submit and obtain a written permit prior to performing "Hot Work" (i.e., welding or cutting) or operating other flame-producing/spark producing devices, from the Fire Division. A permit is required from the Explosives Safety Office for work in and around where explosives are processed, stored, or handled. Contractors are required to meet all criteria before a permit is issued. Provide at least two 20 pound 4A:20 BC rated extinguishers for normal "Hot Work". The extinguishers must be current inspection tagged, and contain an approved safety pin and tamper resistant seal. It is also mandatory to have a designated FIRE WATCH for any "Hot Work" done at this activity. The Fire Watch must be trained in accordance with NFPA 51B and remain on-site for a minimum of 1 hour after completion of the task or as specified on the hot work permit.

When starting work in the facility, require personnel to familiarize themselves with the location of the nearest fire alarm boxes and place in memory the emergency Fire Division phone number. Report any fire, no matter how small, to the responsible Fire Division immediately.

1.13.2 Work Around Flammable Materials

Obtain permit approval from a NFPA Certified Marine Chemist, or Certified Industrial Hygienist for "Hot Work" within or around flammable materials (such as fuel systems or welding/cutting on fuel pipes) or confined spaces (such as sewer wet wells, manholes, or vaults) that have the potential for flammable or explosive atmospheres.

Whenever these materials, except beryllium and chromium (VI), are encountered in indoor operations, local mechanical exhaust ventilation systems that are sufficient to reduce and maintain personal exposures to within acceptable limits must be used and maintained in accordance with manufacturer's instruction and supplemented by exceptions noted in EM 385-1-1.

1.14 RADIATION SAFETY REQUIREMENTS

Submit License Certificates, employee training records, and Leak Test Reports for radiation materials and equipment to the Contracting Officer and Radiation Safety Office (RSO) for all specialized and licensed material and equipment proposed for use on the construction project (excludes portable machine sources of ionizing radiation including moisture density and X-Ray Fluorescence (XRF)). Maintain on-site records whenever licensed radiological materials or ionizing equipment are on Government property.

Protect workers from radiation exposure in accordance with 10 CFR 20, ensuring any personnel exposures are maintained As Low As Reasonably Achievable.

1.14.1 Radiography Operation Planning Work Sheet

Submit a Gamma and X-Ray Radiography Operation Planning Work Sheet to Contracting Officer 14 days prior to commencement of operations involving radioactive materials or radiation generating devices. For portable machine sources of ionizing radiation, including moisture density and XRF, use and submit the Portable Gauge Operations Planning Worksheet instead. The Contracting Officer will review the submitted worksheet and provide questions and comments.

Contractors must use primary dosimeters process by a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory.

1.14.2 Site Access and Security

Coordinate site access and security requirements with the Contracting Officer for all radiological materials and equipment containing ionizing radiation that are proposed for use on a government facility. For gamma radiography materials and equipment, a Government escort is required for any travels on the Installation. The Government authorized representative will meet the Contractor at a designated location outside the Installation, ensure safety of the materials being transported, and will escort the Contractor for gamma sources onto the Installation, to the job site, and off the Installation. For portable machine sources of ionizing radiation, including moisture density and XRF, the Government authorized representative will meet the Contractor at the job site.

Provide a copy of all calibration records, and utilization records for radiological operations performed on the site.

1.14.3 Loss or Release and Unplanned Personnel Exposure

Loss or release of radioactive materials, and unplanned personnel exposures must be reported immediately to the Contracting Officer, RSO, and Base Security Department Emergency Number.

1.14.4 Site Demarcation and Barricade

Properly demark and barricade an area surrounding radiological operations to preclude personnel entrance, in accordance with EM 385-1-1, Nuclear Regulatory Commission, and Applicable State regulations and license requirements, and in accordance with requirements established in the accepted Radiography Operation Planning Work Sheet.

Do not close or obstruct streets, walks, and other facilities occupied and used by the Government without written permission from the Contracting Officer.

1.14.5 Security of Material and Equipment

Properly secure the radiological material and ionizing radiation equipment at all times, including keeping the devices in a properly marked and locked container, and secondarily locking the container to a secure point in the Contractor's vehicle or other approved storage location during transportation and while not in use. While in use, maintain a continuous visual observation on the radiological material and ionizing radiation equipment. In instances where radiography is scheduled near or adjacent to buildings or areas having limited access or one-way doors, make no assumptions as to building occupancy. Where necessary, the Contracting Officer will direct the Contractor to conduct an actual building entry, search, and alert. Where removal of personnel from such a building cannot be accomplished and it is otherwise safe to proceed with the radiography, position a fully instructed employee inside the building or area to prevent exiting while external radiographic operations are in process.

1.14.6 Transportation of Material

Comply with 49 CFR 173 for Transportation of Regulated Amounts of Radioactive Material. Notify Local Fire authorities and the site Radiation Safety Officer (RSO) of any Radioactive Material use.

1.14.7 Schedule for Exposure or Unshielding

Actual exposure of the radiographic film or unshielding the source must not be initiated until after 5 p.m. on weekdays.

1.14.8 Transmitter Requirements

Adhere to the base policy concerning the use of transmitters, such as radios and cell phones. Obey Emissions control (EMCON) restrictions.

1.15 CONFINED SPACE ENTRY REQUIREMENTS

Confined space entry must comply with EM 385-1-1, 29 CFR 1926, 29 CFR 1910, and Directive CPL 2.100. Any potential for a hazard in the confined space requires a permit system to be used.

1.15.1 Rescue Procedures and Coordination with Local Emergency Responders

Develop and implement an on-site rescue and recovery plan and procedures. The rescue plan must not rely on local emergency responders for rescue from a confined space.

1.16 CONSTRUCTION INDOOR AIR QUALITY (IAQ) MANAGEMENT PLAN

Submit an IAQ Management Plan within 15 calendar days after notice to proceed and not less than 10 calendar days before the preconstruction conference. Revise and resubmit Plan as required by the Contracting Officer. Make copies of the final plan available to all workers on site. Include provisions in the Plan to meet the requirements specified below and to ensure safe, healthy air for construction workers and building occupants.

1.16.1 Requirements During Construction

Provide for evaluation of indoor Carbon Dioxide concentrations in accordance with ASTM D6245. Provide for evaluation of volatile organic compounds (VOCs) in indoor air in accordance with ASTM D6345. Use filters with a Minimum Efficiency Reporting Value (MERV) of 8 in permanently installed air handlers during construction.

1.16.1.1 Control Measures

Meet or exceed the requirements of ANSI/SMACNA 008 to help minimize contamination of the building from construction activities. The five requirements of this manual which must be adhered to are described below:

a. HVAC protection: Isolate return side of HVAC system from surrounding environment to prevent construction dust and debris from entering the duct work and spaces.

b. Source control: Use low emitting paints and other finishes, sealants, adhesives, and other materials as specified. When available, cleaning products must have a low VOC content and be non-toxic to minimize building contamination. Utilize cleaning techniques that minimize dust generation. Cycle equipment off when not needed. Prohibit idling motor vehicles where emissions could be drawn into building. Designate receiving/storage areas for incoming material that minimize IAQ impacts.

c. Pathway interruption: When pollutants are generated use strategies such as 100 percent outside air ventilation or erection of physical barriers between work and non-work areas to prevent contamination.

d. Housekeeping: Clean frequently to remove construction dust and debris. Promptly clean up spills. Remove accumulated water and keep work areas dry to discourage the growth of mold and bacteria. Take extra measures when hazardous materials are involved.

e. Scheduling: Control the sequence of construction to minimize the absorption of VOCs by other building materials.

1.16.1.2 Moisture Contamination

a. Remove accumulated water and keep work dry.

b. Use dehumidification to remove moist, humid air from a work area.

c. Do not use combustion heaters or generators inside the building.

d. Protect porous materials from exposure to moisture.

e. Remove and replace items which remain damp for more than a few hours.

1.16.2 Requirements After Construction

After construction ends and prior to occupancy, conduct a building flush-out or test the indoor air contaminant levels. Flush-out must be a minimum 2 weeks with MERV-13 filtration media as determined by ASHRAE 52.2 at 100 percent outside air. Air contamination testing must be consistent with EPA's current Compendium of Methods for the Determination of Air Pollutants in Indoor Air. After building flush-out or testing and prior to occupancy, replace filtration media. Filtration media must have a MERV of 13 as determined by ASHRAE 52.2.

1.17 SEVERE STORM PLAN

In the event of a severe storm warning, the Contractor must comply with the applicable Storm Plan and:

a. Secure outside equipment and materials and place materials that could be damaged in protected areas.

b. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.

c. Ensure that temporary erosion controls are adequate.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 CONSTRUCTION AND OTHER WORK

Comply with EM 385-1-1, NFPA 70, NFPA 70E, NFPA 241, the APP, the AHA, Federal and State OSHA regulations, and other related submittals and activity fire and safety regulations. The most stringent standard prevails.

PPE is governed in all areas by the nature of the work the employee is performing. Use personal hearing protection at all times in designated noise hazardous areas or when performing noise hazardous tasks. Safety glasses must be worn or carried/available on each person. Mandatory PPE includes:

a. Head Protection that meets ANSI/ISEA Z89.1

b. Long Pants

c. Appropriate Safety Footwear

d. Appropriate Class Reflective Vests

3.1.1 Worksite Communication

Employees working alone in a remote location or away from other workers must be provided an effective means of emergency communications (i.e., cellular phone, two-way radios, land-line telephones or other acceptable means). The selected communication must be readily available (easily within the immediate reach) of the employee and must be tested prior to the start of work to verify that it effectively operates in the area/environment. Develop an employee check-in/check-out communication procedure to ensure employee safety.

3.1.2 Hazardous Material Exclusions

Notwithstanding any other hazardous material used in this Contract, radioactive materials or instruments capable of producing ionizing/non-ionizing radiation (with the exception of radioactive material and devices used in accordance with EM 385-1-1 such as nuclear density meters for compaction testing and laboratory equipment with radioactive sources) as well as materials which contain asbestos, mercury or polychlorinated biphenyls, di-isocyanates, lead-based paint, and hexavalent chromium, are prohibited. The Contracting Officer, upon written request by the Contractor, may consider exceptions to the use of any of the above excluded materials. Low mercury lamps used within fluorescent lighting fixtures are allowed as an exception without further Contracting Officer approval. Notify the Radiation Safety Officer (RSO) prior to excepted items of radioactive material and devices being brought on base.

3.1.3 Unforeseen Hazardous Material

Contract documents identify materials such as PCB, lead paint, and friable and non-friable asbestos and other OSHA regulated chemicals (i.e., 29 CFR Part 1910.1000). If material(s) that may be hazardous to human health upon disturbance are encountered during demolition, repair, renovation, or construction operations. Stop that portion of work and notify the Contracting Officer immediately. Within 14 calendar days the Government will determine if the material is hazardous. If material is not hazardous or poses no danger, the Government will direct the Contractor to proceed without change. If material is hazardous and handling of the material is necessary to accomplish the work, the Government will issue a modification.

3.2 UTILITY OUTAGE REQUIREMENTS

Apply for utility outages per Section 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS. At a minimum, the written request must include the location of the outage, utilities being affected, duration of outage, any necessary sketches, and a description of the means to fulfill energy isolation requirements in accordance with EM 385-1-1. In accordance with EM 385-1-1, where outages involve Government or Utility personnel, coordinate with the Government on all activities involving the control of hazardous energy.

These activities include, but are not limited to, a review of Hazardous Energy Control Program (HECP) and HEC procedures, as well as applicable Activity Hazard Analyses (AHAs). In accordance with EM 385-1-1 and NFPA 70E, work on energized electrical circuits must not be performed without prior Government authorization. Government permission is considered through the permit process and submission of a detailed AHA.

Energized work permits are considered only when de-energizing introduces additional or increased hazard or when de-energizing is infeasible.

3.3 OUTAGE COORDINATION MEETING

After the utility outage request is approved and prior to beginning work on the utility system requiring shut-down, conduct a pre-outage coordination meeting in accordance with EM 385-1-1. This meeting must include the Prime Contractor, the Prime and subcontractors performing the work, the Contracting Officer, and the Installation or Public Utilities representative. All parties must fully coordinate HEC activities with one another. During the coordination meeting, all parties must discuss and coordinate on the scope of work, HEC procedures (specifically, the lock-out/tag-out procedures for worker and utility protection), the AHA, assurance of trade personnel qualifications, identification of competent persons, and compliance with HECP training in accordance with EM 385-1-1. Clarify when personal protective equipment is required during switching operations, inspection, and verification.

3.4 CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)

Provide and operate a Hazardous Energy Control Program (HECP) in accordance with EM 385-1-1, 29 CFR 1910, 29 CFR 1915, ANSI/ASSP A10.44, NFPA 70E.

3.4.1 Safety Preparatory Inspection Coordination Meeting with the Government or Utility

For electrical distribution equipment that is to be operated by Government or Utility personnel, the Prime Contractor and the subcontractor performing the work must attend the safety preparatory inspection coordination meeting, which will also be attended by the Contracting Officer's Representative, and required by EM 385-1-1. The meeting will occur immediately preceding the start of work and following the completion of the outage coordination meeting. Both the safety preparatory inspection coordination meeting and the outage coordination meeting must occur prior to conducting the outage and commencing with lockout/tagout procedures.

3.4.2 Lockout/Tagout Isolation

Where the Government or Utility performs equipment isolation and lockout/tagout, the Contractor must place their own locks and tags on each energy-isolating device and proceed in accordance with the HECP. Before any work begins, both the Contractor and the Government or Utility must perform energy isolation verification testing while wearing required PPE detailed in the Contractor's AHA and required by EM 385-1-1. Install personal protective grounds, with tags, to eliminate the potential for induced voltage in accordance with EM 385-1-1.

3.4.3 Lockout/Tagout Removal

Upon completion of work, conduct lockout/tagout removal procedure in accordance with the HECP. In accordance with EM 385-1-1, each lock and tag must be removed from each energy isolating device by the authorized individual or systems operator who applied the device. Provide formal notification to the Government (by completing the Government form if provided by Contracting Officer's Representative), confirming that steps of de-energization and lockout/tagout removal procedure have been

conducted and certified through inspection and verification. Government or Utility locks and tags used to support the Contractor's work will not be removed until the authorized Government employee receives the formal notification.

3.5 Planning for Energization of New Powerplant from Permanent Medium Voltage Source

The powerplant may not connect to permanent medium voltage power nor may medium-voltage switches be placed on manholes ST-MH-3 or ST-MH-5 until the following has occurred:

1. The manholes and interconnecting infrastructure have become government property at the conclusion of the contract installing said infrastruction.

2. The Xcel Energy capacity reserved for this infrastructure at the Automatic Throwover Switch (interface between private utility ownership and government ownership) has been increased under this contract.

3.6 Planning for Building 442 Transition from ADF-C Power Supply to New Powerplant

Minimum 120-day notice shall be provided to 460 CES to prepare for B442 electrical service crossover. Commissioning of new powerplant must be established before B442 power can be switched from ADF-C power (existing condition) to new powerplant service. Methods and Procedures (MAPS) must be written and rehearsed in detail before crossover may occur. Coordination with Xcel Energy and ADF-C (Aerospace Data Facility Power) must be established and ongoing. All of Buckley AFB's mission is involved for this procedure. Planning and proper execution are key to Buckley AFB's survival of this project. Any weak point in the crossover must be found and averted.

3.7 FALL PROTECTION PROGRAM

Establish a fall protection program, for the protection of all employees exposed to fall hazards. Within the program include company policy, identify roles and responsibilities, education and training requirements, fall hazard identification, prevention and control measures, inspection, storage, care and maintenance of fall protection equipment and rescue and evacuation procedures in accordance with EM 385-1-1.

3.7.1 Fall Protection Equipment and Systems

Enforce use of personal fall protection equipment and systems designated (to include fall arrest, restraint, and positioning) for each specific work activity in the Site Specific Fall Protection and Prevention Plan and AHA at all times when an employee is exposed to a fall hazard. Protect employees from fall hazards as specified in EM 385-1-1.

Provide personal fall protection equipment, systems, subsystems, and components that comply with EM 385-1-1 and 29 CFR 1926.

3.7.1.1 Additional Personal Fall Protection Measures

In addition to the required fall protection systems, other protective measures such as safety skiffs, personal floatation devices, and life

rings, are required when working above or next to water in accordance with EM 385-1-1. Personal fall protection systems and equipment are required when working from an articulating or extendible boom, swing stages, or suspended platform. In addition, personal fall protection systems are required when operating other equipment such as scissor lifts. The need for tying-off in such equipment is to prevent ejection of the employee from the equipment during raising, lowering, travel, or while performing work.

3.7.1.2 Personal Fall Protection Equipment

Only a full-body harness with a shock-absorbing lanyard or self-retracting lanyard is an acceptable personal fall arrest body support device. The use of body belts is not acceptable. Harnesses must have a fall arrest attachment affixed to the body support (usually a Dorsal D-ring) and specifically designated for attachment to the rest of the system. Snap hooks and carabineers must be self-closing and self-locking, capable of being opened only by at least two consecutive deliberate actions and have a minimum gate strength of 3,600 lbs in all directions. Use webbing, straps, and ropes made of synthetic fiber. The maximum free fall distance when using fall arrest equipment must not exceed 6 feet, unless the proper energy absorbing lanyard is used. Always take into consideration the total fall distance and any swinging of the worker (pendulum-like motion), that can occur during a fall, when attaching a person to a fall arrest system. Equip all full body harnesses with Suspension Trauma Preventers such as stirrups, relief steps, or similar in order to provide short-term relief from the effects of orthostatic intolerance in accordance with EM 385-1-1.

3.8 USE OF EXPLOSIVES

Explosives must not be used or brought to the project site without prior written approval from the Contracting Officer. Such approval does not relieve the Contractor of responsibility for injury to persons or for damage to property due to blasting operations.

Storage of explosives, when permitted on Government property, must be only where directed and in approved storage facilities. These facilities must be kept locked at all times except for inspection, delivery, and withdrawal of explosives.

3.9 ELECTRICAL

Perform electrical work in accordance with EM 385-1-1.

3.9.1 Electrical Work

As described in EM 385-1-1, electrical work is to be conducted in a de-energized state unless there is no alternative method for accomplishing the work. In those cases obtain an energized work permit from the Contracting Officer. The energized work permit application must be accompanied by the AHA and a summary of why the equipment/circuit needs to be worked energized. Underground electrical spaces must be certified safe for entry before entering to conduct work. Cables that will be cut must be positively identified and de-energized prior to performing each cut. Attach temporary grounds in accordance with ASTM F855 and IEEE 1048. Perform all high voltage cable cutting remotely using hydraulic cutting tool. When racking in or live switching of circuit breakers, no additional person other than the switch operator is allowed in the space

during the actual operation. Plan so that work near energized parts is minimized to the fullest extent possible. Use of electrical outages clear of any energized electrical sources is the preferred method.

When working in energized substations, only qualified electrical workers are permitted to enter. When work requires work near energized circuits as defined by NFPA 70, high voltage personnel must use personal protective equipment that includes, as a minimum, electrical hard hat, safety footwear, insulating gloves and electrical arc flash protection for personnel as required by NFPA 70E. Insulating blankets, hearing protection, and switching suits may also be required, depending on the specific job and as delineated in the Contractor's AHA. Ensure that each employee is familiar with and complies with these procedures and 29 CFR 1910.

3.9.2 Qualifications

Electrical work must be performed by QP with verifiable credentials who are familiar with applicable code requirements. Verifiable credentials consist of State, National and Local Certifications or Licenses that a Master or Journeyman Electrician may hold, depending on work being performed, and must be identified in the appropriate AHA. Journeyman/Apprentice ratio must be in accordance with State, Local requirements applicable to where work is being performed.

3.9.3 Arc Flash

Conduct a hazard analysis/arc flash hazard analysis whenever work on or near energized parts greater than 50 volts is necessary, in accordance with NFPA 70E.

All personnel entering the identified arc flash protection boundary must be QPs and properly trained in NFPA 70E requirements and procedures. Unless permitted by NFPA 70E, no Unqualified Person is permitted to approach nearer than the Limited Approach Boundary of energized conductors and circuit parts. Training must be administered by an electrically qualified source and documented.

3.9.4 Grounding

Ground electrical circuits, equipment and enclosures in accordance with NFPA 70 and IEEE C2 to provide a permanent, continuous and effective path to ground unless otherwise noted by EM 385-1-1.

3.9.5 Testing

Temporary electrical distribution systems and devices must be inspected, tested and found acceptable for Ground-Fault Circuit Interrupter (GFCI) protection, polarity, ground continuity, and ground resistance before initial use, before use after modification and at least monthly. Monthly inspections and tests must be maintained for each temporary electrical distribution system, and signed by the electrical CP or QP.

-- End of Section --

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(FEDERAL FACILITIES COLORADO) NPDES PERMIT REQUIREMENTS FOR STORM WATER DISCHARGES FROM CONSTRUCTION SITES

05/24

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SECTION 01 41 26.05 24

(FEDERAL FACILITIES COLORADO) NPDES PERMIT REQUIREMENTS FOR STORM WATER DISCHARGES FROM CONSTRUCTION SITES
05/24

PART 1 GENERAL

1.1 REFERENCES (Not Applicable)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Inspector Qualifications

Inspection Certification

Stormwater Notice Of Intent; G, RO

Stormwater Pollution Prevention Plan; G, RO

SD-11 Closeout Submittals

Stormwater Notice Of Termination; G, RO

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL

Implement the terms and requirements of the Enivornmental Protection Agency's (EPA) 2022 Construction General Permit (CGP) for the National Pollutant Discharge Elimination System (NPDES), https://www.epa.gov/npdes/2022-construction-general-permit-cgp#2022cgp as specified below. The EPA considers the Government and the Contractor co-permittees. The Government has operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications. The Contractor has day-to-day operational control of those activities which are necessary to ensure compliance with the requirements specified herein. Submit to the EPA and retain the official copy of all documents pertaining to compliance with the CGP during construction. The project site is not located in designated critical habitat and there are no known "listed species" located in the project area.

3.2 IMPLEMENTATION

Comply with the requirements of all NPDES permits, including the Buckley SFB Municipal Separate Storm Sewer System (MS4) permit conditions. A copy of this permit may be found on the EPA website: https://www.epa.gov/npdes-permits/npdes-permit-buckley-space-force-base-municipal-separate-storm-sewer-system-colorado

3.2.1 Stormwater Notice Of Intent

Electronically complete and sign a Stormwater Notice of Intent (NOI) as co-permittee in accordance with the Permit. Notify the Contracting Officer's Representative within 24 hours after submitting NOI and provide a copy of the NOI. Do not submit NOI to the EPA until the Government accepts the Storm Water Pollution Prevention Plan. After completion of the electronic NOI, a 14-calendar day waiting period begins. The EPA will give the Contractor authorization that the NOI is in effect after the 14-day waiting period. Do not begin land disturbance activities until the NOI is in effect and authorized by the Contracting Officer. Take site pictures that document stabilized surface conditions prior to the start of construction.

3.2.2 Storm Water Pollution Prevention Plan

3.2.2.1 General

Prepare a Stormwater Pollution Prevention Plan (SWPPP) for the project. Inlcude all requirements described in the CGP. Buckley SFB maintains a Buckley-specific SWPPP template. Contact 460 CES/CEIE stormwater coordinator, Greg Vierra (gregory.vierra.2.ctr@spaceforce.mil; 720-847-6308) to obtain and use a copy of the Buckley stormwater pollution prevention plan (SWPPP) template. Include appropriate controls and measures for any off-site support activities covered under the CGP. Describe the nature and location of the activity and include a location map and site map in accordance with the CGP. Implement, maintain and update the SWPPP (including Site Map) during construction. Unless otherwise indicated, implement all measures described in the SWPPP. Maintain the following records and attach to the SWPPP: the dates when major grading activities occur; the dates when construction activities temporarily or permanently cease on a portion of the site; and the dates when stabilization measures are initiated. Sign the SWPPP and attach a copy of the written authorization to the SWPPP for any person signing the SWPPP or Inspection Reports other than the person described in the CGP. If major changes to the SWPPP are required during construction, recertify the SWPPP.

3.2.2.2 Acceptance of SWPPP

Government acceptance of the SWPPP is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Government reserves the right to require the Contractor to make changes to the SWPPP if the Contracting Officer determines that environmental protection requirements are not being met.

3.2.2.3 Notification of Changes

After acceptance of the SWPPP, notify the Contracting Officer in writing of any proposed change. Proposed changes are subject to acceptance by the

Contracting Officer.

3.2.3 Posting Notice

Post copies of each of the NOI's electronically submitted to the EPA using the NPDES eReporting Tool or "NeT" system. Post the NOI conspicuously near the main entrance of the construction site.

3.2.4 Inspections and Reporting

Perform all inspections required by the CGP. Prepare and sign all reports summarizing the inspections as required by the CGP. Attach copies of inspection reports to the SWPPP and provide to the Contracting Officer's Representative within 24 hours after completion of each inspection. Notify the Contracting Officer within 24 hours if an inspection identifies any incidents of non-compliance with the SWPPP and the CGP.

While the project is covered under one or more NPDES permits, the project site will be subject to recurring site compliance inspections at least every 45-days. These inspections may be accomplished together with other routine site walks but must assess the criteria outlined by the Buckley MS4 permit, be signed, dated, and kept together onsite with the project SWPPP. The inspection criteria can be received from 460 CES/CEIE Water Quality program.

3.2.4.1 Inspector Qualifications

Contractor personnel performing inspections shall be knowledgeable in the principles and practice of erosion and sediment controls and possess the skills to assess conditions at the construction site that could impact storm water quality and to assess the effectiveness of any sediment and erosion control measures selected to control the quality of storm water discharges from the construction site. Submit the name, qualifications, and inspection certification of all personnel who will be performing inspections on the site.

Ensure those who wish to be considered a qualified person to conduct inspections under Part 4 of the EPA’s 2022 CGP, at a minimum, either:

Complete EPA’s construction inspection training course (https://www.epa.gov/npdes/construction-inspection-training-course) or Hold a current valid construction inspection certification or license from a program that, at a minimum, covers principles and practices of erosion control and pollution prevention practices at construction sites; proper installation and maintenance of erosion and sediment controls and pollution prevention practices used at construction sites; and performance of inspections, including the proper completion of required reports and documentation, consistent with Part 4 of the 2022 CGP.

3.2.5 Maintenance

Maintain all erosion and sediment control measures and other protective measures identified in the SWPPP in an effective operating condition. The Government reserves the right to require the Contractor to perform maintenance on erosion and sediment control measures and other protective measures if the Contracting Officer determines that environmental protection requirements are not being met.

3.2.6 Stormwater Notice Of Termination

Establish a stand of grass in all disturbed areas of the project not otherwise surfaced meeting the requirements for "Final Stabilization" as defined in the CGP prior to terminating permit coverage. Notify the Contracting Officer within 2 working days after achieving final stabilization on all portions of the site in accordance with the CGP. Schedule final stabilization site walk with 460 CES/CEIE prior to submitting the Notice of Termination (NOT). 460 CES/CEIE must agree that final stabilization criteria has been satisfied. Electronically complete and sign a Notice of Termination (NOT) in accordance with the CGP. Furnish a copy of the Contractor's NOT and the updated SWPPP to the Contracting Officer within 5 calendar days after achieving final stabilization on all portions of the site.

3.2.7 Retention of Records

After submission of the NOT, the Government will retain copies of the SWPPP and all reports in accordance with the CGP.

3.2.8 Continuation of Expired Permit

If the current CGP expires prior to completion of construction, comply with the conditions of the new permit.

-- End of Section --

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SOURCES FOR REFERENCE PUBLICATIONS
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PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization (e.g., ASTM B564 Standard Specification for Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided.

AACE INTERNATIONAL (AACE)
726 East Park Avenue #180
Fairmont, WV 26554 USA
Ph: 304-296-8444
Fax: 304-291-5728
Internet: https://web.aacei.org/

ACOUSTICAL SOCIETY OF AMERICA (ASA)
1305 Walt Whitman Road, Suite 110
Melville, NY 11747-4300
Ph: 516-576-2360
Fax: 631-923-2875
E-mail: asa@acousticalsociety.org
Internet: https://acousticalsociety.org/

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)
30 West University Drive
Arlington Heights, IL 60004-1893
Ph: 847-394-0150
Fax: 847-253-0088
E-mail: communications@amca.org
Internet: http://www.amca.org

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)
2311 Wilson Blvd, Suite 400
Arlington, VA 22201
Ph: 703-524-8800
Internet: http://www.ahrinet.org

ALUMINUM ASSOCIATION (AA)
1400 Crystal Drive
Suite 430

Arlington, VA 22202
Ph: 703-358-2960

Internet: https://www.aluminum.org/

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)
1900 E Golf Rd, Suite 1250
Schaumburg, IL 60173
Ph: 847-303-5664
E-mail: customerservice@FGIAonline.org
Internet: https://fgiaonline.org/

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
555 12th Street NW, Suite 1000
Washington, DC 20004
Ph: 202-624-5800
Fax: 202-624-5806
E-Mail: info@aashto.org
Internet: https://www.transportation.org/

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)
1001 N. Fairfax Street Suite 500
Alexandria, VA 22314
Ph: 703-842-0030
E-mail: info@americanbearings.org
Internet: https://www.americanbearings.org/

AMERICAN CONCRETE INSTITUTE (ACI)
38800 Country Club Drive
Farmington Hills, MI 48331-3439
Ph: 248-848-3800
Fax: 248-848-3701
Internet: https://www.concrete.org/

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)
3640 Park 42 Drive
Cincinnati, OH 45241
Ph: 513-742-2020
Fax: 513-742-3355
Email: customerservice@acgih.org
Internet: https://www.acgih.org/

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)
1001 N. Fairfax Street, Suite 500
Alexandria, VA 22314-1587
Ph: 703-684-0211
Fax: 703-684-0242
E-mail: tech@agma.org
Internet: https://www.agma.org/

AMERICAN HARDBOARD ASSOCIATION (AHA)
1210 West Northwest Highway
Palatine, IL 60067
Ph: 847-934-8800
Fax: 847-934-8803
E-mail: aha@hardboard.org
Internet: http://domensino.com/AHA/

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)
130 East Randolph, Suite 2000
Chicago, IL 60601
Ph: 312-670-2400
Fax: 312-670-5403
Steel Solutions Center: 866-275-2472
E-mail: solutions@aisc.org
Internet: https://www.aisc.org/

AMERICAN IRON AND STEEL INSTITUTE (AISI)
25 Massachusetts Avenue, NW Suite 800
Washington, DC 20001
Ph: 202-452-7100
Internet: https://www.steel.org/

AMERICAN LADDER INSTITUTE (ALI)
1300 Summer Avenue
Clevelan, OH 44115
Ph: 216-241-7333
Fax: 216-241-0105
E-mail: info@americanladderinstitute.org
Internet: https://www.americanladderinstitute.org

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)
7470 New Technology Way, Suite F
Frederick, MD 21703
Ph: 301-972-1700
Fax: 301-540-8004
E-mail: alsc@alsc.org
Internet: http://www.alsc.org

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1899 L Street, NW,11th Floor
Washington, DC 20036
Ph: 202-293-8020
Fax: 202-293-9287
E-mail: info@ansi.org
Internet: https://www.ansi.org/

AMERICAN PETROLEUM INSTITUTE (API)
200 Massachusetts Avenue NW Suite 1100
Washington, DC 20001-5571
Ph: 202-682-8000
Internet: https://www.api.org/

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)
4471 Nicole Drive, Unit 1
Lanham, MD 20706
Ph: 301-459-3200
E-mail: info@arema.org
Internet: https://www.arema.org

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)
1201 Dublin Road Suite G04

Columbus, OH 43215-1045
Ph: 800-222-2768 or 614-274-6003

E-mail: customersupport@asnt.org
Internet: https://www.asnt.org/

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)
1801 Alexander Bell Drive
Reston, VA 20191
Ph: 800-548-2723; 703-295-6300
Email: customercare@asce.org
Internet: https://www.asce.org/

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)
180 Technology Parkway NW
Peachtree Corners, GA 30092
Ph: 404-636-8400 or 800-527-4723
Fax: 404-321-5478
E-mail: ashrae@ashrae.org
Internet: https://www.ashrae.org/

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
Two Park Avenue
New York, NY 10016-5990
Ph: 800-843-2763
Fax: 973-882-1717
E-mail: customercare@asme.org
Internet: https://www.asme.org/

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)
520 N. Northwest Highway
Park Ridge, IL 60068
Ph: 847-699-2929
E-mail: customerservice@assp.org
Internet: https://www.assp.org/

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)
18927 Hickory Creek Drive, Suite 220
Mokena, IL 60448
Ph: 708-995-3019
Fax: 708-479-6139
Internet: http://www.asse-plumbing.org

AMERICAN WATER WORKS ASSOCIATION (AWWA)
6666 W. Quincy Avenue
Denver, CO 80235 USA
Ph: 303-794-7711 or 800-926-7337
Fax: 303-347-0804
Internet: https://www.awwa.org/

AMERICAN WELDING SOCIETY (AWS)
8669 NW 36 Street, #130
Miami, FL 33166-6672
Ph: 800-443-9353
Email: customercare@aws.org
Internet: https://www.aws.org/

AMERICAN WOOD COUNCIL (AWC)
50 Catoctin Circle SE, Suite 201
Leesburg, VA 20176
Ph: 800-890-7732 or 202-463-2766

Fax: 412-741-0609
E-mail: info@awc.org
Internet: https://www.awc.org/

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)
P.O. Box 361784
Birmingham, AL 35236-1784
Ph: 205-733-4077
Fax: 205-733-4075
Internet: http://www.awpa.com

APA - THE ENGINEERED WOOD ASSOCIATION (APA)
7011 South 19th St.
Tacoma, WA 98466-5333
Ph: 253-565-6600
Fax: 253-565-7265
Internet: https://www.apawood.org/

ASSOCIATED AIR BALANCE COUNCIL (AABC)
1015 18th St. NW Suite 603
Washington, DC 20036
Ph: 202-737-0202
Fax: 202-315-0285
E-mail: info@aabc.com
Internet: https://www.aabc.com/

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

P.O. Box 58130
Washington, DC 20037
Ph: 205-257-3839
Fax: 205-257-2540
Internet: https://aeic.org/

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9500
Fax: 610-832-9555
E-mail: service@astm.org
Internet: https://www.astm.org/

BACNET TESTING LABORATORIES (BTL)
BACnet Testing Laboratories
2900 Delk Road
Suite 700, PMB 321
Marietta, GA 30067
Ph: 770-971-6003
Fax: 678-229-2777

Internet: https://www.btl.org/

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)
529 14th Street NW Suite 1280
Washington, DC 20045
Ph: 212-297-2122
Fax: 212-370-9047
Internet: https://www.buildershardware.com/

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)
PO Box 997377, MS 0500
Sacramento, CA 95899-7377
Ph: 916-558-1784
Internet: https://www.cdph.ca.gov/

CAST IRON SOIL PIPE INSTITUTE (CISPI)
2401 Fieldcrest Drive
Mundelein, IL 60060
Ph: 224-864-2910
Internet: https://www.cispi.org/

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)
1600 Clifton Road
Atlanta, GA 30329-4027
Ph: 800-232-4636
TTY: 888-232-6348
Internet: https://www.cdc.gov

COMPRESSED GAS ASSOCIATION (CGA)
8484 Westpark Drive Suite 220
McLean, Virginia 22102
Ph: 703-788-2700
Fax: 703-961-1831
E-mail: cga@cganet.com
Internet: https://www.cganet.com/

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)
933 North Plum Grove Road
Schaumburg, IL 60173-4758
Ph: 847-517-1200
Email: crsi@crsi.org
Fax: 847-517-1206
Internet: http://www.crsi.org/

CONSUMER ELECTRONICS ASSOCIATION (CEA)
1919 South Eads St.
Arlington, VA 22202
Ph: 703-907-7600
E-mail: CTA@CTA.tech
Internet: https://www.cta.tech/

COPPER DEVELOPMENT ASSOCIATION (CDA)
Internet: https://www.copper.org/

COUNCIL ON ENVIRONMENTAL QUALITY (CEQ) (WHITE HOUSE)
722 Jackson Place
Washington DC 20506
Internet: https://www.whitehouse.gov/administration/eop/ceq

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)
8720 Red Oak Boulevard, Suite 201
Charlotte, NC 28217-3992
Ph: 704-676-1190
Fax: 704-676-1199
Internet: http://www.mhi.org/cmaa

DOOR AND ACCESS SYSTEM MANUFACTURERS ASSOCIATION (DASMA)
1300 Sumner Avenue
Cleveland, OH 44115-2851
Ph: 216-241-7333
Fax: 216-241-0105
Email dasma@dasma.com
Internet: https://www.dasma.com/

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)
P.O. Box 73206
Washington, DC 20056
Ph: 561-750-5575
Fax: 561-395-8557
Email: e-mail@egsa.org
Internet: http://www.egsa.org

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)
310 Maxwell Road, Suite 200
Alpharetta, GA 30009
Ph: 678-393-9990
Fax: 678-393-9998
E-mail: emikoski@ecianow.org
Internet: https://www.ecianow.org

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN/CENELEC)
CEN-CENELEC Management Centre
Rue de la Science 23
B - 1040 Brussels, Belgium
Ph: 32-2-550-08-11
Fax: 32-2-550-08-19
Internet: https://www.cencenelec.eu/

EUROPEAN UNION (EU)
European Commission
Rue de la Loi 200
1000 Bruxelle
Belgium
Ph: +32 2 299 96 96
Internet: https://commission.europa.eu/index_en

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)
615 Chestnut Street
One Independence Mall, Sixth Floor
Philadelphia, PA 19106-4404
Ph: 215-931-5597
E-mail: femar3newsdesk@fema.dhs.gov
Internet: https://www.fema.gov/

FM GLOBAL (FM)
270 Central Avenue
Johnston, RI 02919-4949
Ph: 401-275-3000
Fax: 401-275-3029
Internet: https://www.fmglobal.com/

FOREST STEWARDSHIP COUNCIL (FSC)
1441 Woodmont Ln NW #539
Atlanta, GA 30318
Ph: 612-353-4511

E-mail: info@us.fcs.org
Internet: https://us.fsc.org/

GLASS ASSOCIATION OF NORTH AMERICA (GANA)
National Glass Association
1945 Old Gallows Rd., Suite 750
Vienna, VA 22182
Ph: 866-342-5642
Ph: 703-442-4890
Fax: 703-442-0630
Internet: https://www.glass.org/

GREEN SEAL (GS)
601 13th St NW 12th Floor
Washington, DC 20005
Ph: 202-872-6400
Fax: 202-872-4324
E-mail: greenseal@greenseal.org
Internet: https://www.greenseal.org/

GYPSUM ASSOCIATION (GA)
962 Wayne Ave., Suite 620
Silver Spring, MD 20910
Ph: 301-277-8686
Fax: 301-277-8747
E-mail: info@gypsum.org
Internet: https://www.gypsum.org/

HYDRAULIC INSTITUTE (HI)
300 Interpace Parkway
Parsippany, NJ 07054-4405
Ph: 973-267-9700
Fax: 973-267-9055
Internet: http://www.pumps.org

ICC EVALUATION SERVICE, INC. (ICC-ES)
3060 Saturn Street, Suite 100
Brea, CA 92821
Ph: 800-423-6587
Fax: 562-695-4694
E-mail: es@icc-es.org
Internet: https://icc-es.org/

ILLUMINATING ENGINEERING SOCIETY (IES)
120 Wall Street, Floor 17
New York, NY 10005-4001
Ph: 212-248-5000
Fax: 212-248-5018
E-mail: membership@ies.org
Internet: https://www.ies.org/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)
445 and 501 Hoes Lane
Piscataway, NJ 08854-4141
Ph: 732-981-0060 or 800-701-4333
Fax: 732-981-9667
E-mail: onlinesupport@ieee.org
Internet: https://www.ieee.org/

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
P.O. Box 493
Miamitown, OH 45041-9998
E-mail: info@icea.net
Internet: https://www.icea.net/

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)
27 N. Wacker Dr. Suite 365
Chicago, IL 60606-2800
Ph: 613-233-1510
Fax: 613-482-9436
E-mail: enquiries@igmaonline.org
Internet: https://fgiaonline.org//

INTELLIGENCE COMMUNITY STANDARD (ICS)
Homeland Security Digital Library
Ph: 831-272-2437
E-mail: hsdl@nps.edu
Internet: https://www.hsdl.org/c/

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)
4755 E. Philadelphia St.
Ontario, CA 91761
Ph: 909-472-4100
Fax: 909-472-4150
E-mail: iapmo@iapmo.org
Internet: http://www.iapmo.org

INTERNATIONAL CODE COUNCIL (ICC)
200 Massachusetts Ave, NW Suite 250
Washington, DC 20001
Ph: 800-786-4452 or 888-422-7233
Fax: 202-783-2348
E-mail: order@iccsafe.org
Internet: https://www.iccsafe.org/

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)
3050 Old Centre Ave. Suite 101
Portage, MI 49024
Ph: 269-488-6382 or 1-888-300-6382
Fax: 269-488-6383
Internet: https://www.netaworld.org/

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)
3, rue de Varembe, 1st floor
P.O. Box 131
CH-1211 Geneva 20, Switzerland
Ph: 41-22-919-02-11
Fax: 41-22-919-03-00
E-mail: info@iec.ch
Internet: https://www.iec.ch/

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)
ISO Central Secretariat
BIBC II
Chemin de Blandonnet 8
CP 401 - 1214 Vernier, Geneva
Switzerland

Ph: 41-22-749-01-11
E-mail: central@iso.ch
Internet: https://www.iso.org

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)
1101 Wilson Blvd, Suite 1425
Arlington, VA 22209-1762
Ph: 703-525-1695
Fax: 703-528-2148
Internet: https://safetyequipment.org/

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)
67 T.W. Alexander Drive
PO Box 12277
Research Triangle Park, NC 27709
Ph: 919-549-8411
Fax: 919-549-8288
E-mail: info@isa.org
Internet: https://www.isa.org/

INTERNET ENGINEERING TASK FORCE (IETF)
c/o Association Management Solutions, LLC (AMS)
5177 Brandin Court
Fremont, California 94538
Ph: 510-492-4080
Fax: 510-492-4001
E-mail: ietf-info@ietf.org
Internet: https://www.ietf.org/

LONMARK INTERNATIONAL (LonMark)
111 Deerwood Road, Suite 200
San Ramon, CA 94583
Ph: 866-566-6275 or 408-790-3247
Fax: 408-790-3838
Email: admin@lonmark.org
Internet: http://www.lonmark.org

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)
127 Park Street, NE
Vienna, VA 22180-4602
Ph: 703-281-6613
E-mail: info@msshq.org
Internet: http://msshq.org

MASTER PAINTERS INSTITUTE (MPI)
2800 Ingleton Avenue
Burnaby, BC CANADA V5C 6G7
Ph: 1-888-674-8937
Fax: 1-888-211-8708
E-mail: info@paintinfo.com or techservices@mpi.net
Internet: http://www.mpi.net/

METAL FRAMING MANUFACTURERS ASSOCIATION (MFMA)
330 N. Wabash Avenue
Chicago, IL 60611
Ph: 312-644-6610
E-mail: MFMAstats@smithbucklin.com
Internet: http://www.metalframingmfg.org/

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)
7250 Poe Avenue, Suite 410
Dayton, OH 45414
Ph: 888-294-0084
Fax: 937-278-0317
Email: info@micainsulation.org
Internet: https://www.micainsulation.org/

MODBUS ORGANIZATION, INC (MODBUS)
800 Federal St.
Andover, MA 01810
Ph: 508-435-7170
Fax: 508-435-7172
Internet: http://www.modbus.org

NACE INTERNATIONAL (NACE)
15835 Park Ten Place
Houston, TX 77084
Ph: 281-228-6200
Fax: 281-228-6300
E-mail: firstservice@nace.org
Internet: https://www.ampp.org/home

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)
800 Roosevelt Road, Bldg C, Suite 312
Glen Ellyn, IL 60137
Ph: 630-942-6591
Fax: 630-790-3095
E-mail: info@naamm.org
Internet: http://www.naamm.org

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)
1201 Pennsylvania Ave. NW, Suite 1200
Washington, DC 20004
Ph: 202-991-6300
Fax: 202-217-4171
Internet: https://www.necanet.org/

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
1300 North 17th Street, Suite 900
Arlington, VA 22209
Ph: 703-841-3200
Email: communications@nema.org
Internet: https://www.nema.org

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)
8575 Grovemont Circle
Gaithersburg, MD 20877
Ph: 301-977-3698
Fax: 301-977-9589
Internet: http://www.nebb.org

NATIONAL FENESTRATION RATING COUNCIL (NFRC)
6305 Ivy Lane, Suite 140
Greenbelt, MD 20770
Ph: 301-589-1776
Fax: 301-589-3884
E-Mail: info@nfrc.org

Internet: http://www.nfrc.org

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
1 Batterymarch Park
Quincy, MA 02169-7471
Ph: 800-344-3555
Fax: 800-593-6372
Internet: https://www.nfpa.org

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)
1420 King Street
Alexandria, VA 22314-2794
Ph: 888-476-4238 (1-888 IS-NICET)
E-mail: tech@nicet.org
Internet: https://www.nicet.org/

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)
Patriots Plaza 1
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Obtain Unified Facilities Criteria (UFC) from:
Whole Building Design Guide (WBDG)
National Institute of Building Sciences (NIBS)
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https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc

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E-mail: info@viscma.com
Internet: http://www.viscma.com

PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

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SECTION 01 45 00

QUALITY CONTROL

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SECTION 01 45 00

QUALITY CONTROL
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D3740	(2019) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 PAYMENT

Separate payment will not be made for providing and maintaining an effective Quality Control program. Include all associated costs in the applicable Pricing Schedule item.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-01 Preconstruction Submittals

Contractor Quality Control (CQC) Plan; G, RO

SD-06 Test Reports

Verification Statement

SD-07 Certificates

Certificate Of Readiness; G, RO

1.4 GENERAL REQUIREMENTS

Establish and maintain an effective quality control (QC) system that complies with FAR 52.246-12 Inspection of Construction. QC is comprised of plans, procedures, and organization necessary to produce an end product that complies with the Contract requirements. The QC system covers all construction operations, both onsite and offsite, and must be keyed to the proposed construction sequence. The Quality Control Manager, Superintendent, Site Safety and Health Officer (SSHO), and all on-site supervisors are responsible for the quality of work and are subject to removal by the Contracting Officer for non-compliance with the quality requirements specified in the Contract. The Quality Control Manager must maintain a physical presence at the work site at all times and is the primary individual responsible for all quality control. "Work site" is defined as the physical location of construction activities.

1.5 QUALITY CONTROL (QC) PROGRAM REQUIREMENTS

Establish and maintain a QC program as described in this section. This QC program is a key element in meeting the objectives of the Commissioning Process (Cx). The QC program consists of a QC Organization, QC Plan, QC Plan Meeting(s), a Coordination and Mutual Understanding Meeting, QC meetings, three phases of control, submittal review and approval, testing, completion inspections, QC certifications, independent Special Inspections in accordance with Section 01 45 35 SPECIAL INSPECTIONS, and documentation necessary to provide materials, equipment, workmanship, fabrication, construction and operations that comply with the requirements of this Contract. The QC program must cover on-site and off-site work and be keyed to the work sequence. No construction work or testing may be performed unless the QC Manager is on the work site. The QC Manager must report to an officer of the firm and not be subordinate to the Project Superintendent or the Project Manager. The QC Manager, Project Superintendent and Project Manager must work together effectively. Although the QC Manager is the primary individual responsible for quality control, all individuals will be held responsible for the quality of work on the job.

1.5.1 Meetings

1.5.1.1 Quality Control Plan Meeting

Prior to submission of the QC Plan, the Contractor may request a meeting with the Contracting Officer to discuss the QC Plan requirements of this Contract.

The purpose of this meeting is to develop a mutual understanding of the QC Plan requirements prior to plan development and submission and to agree on the Contractor's list of Definable Feature of Work (DFOW).

1.5.1.2 Coordination and Mutual Understanding Meeting

After the Preconstruction Conference, before start of construction, and prior to acceptance by the Government of the CQC Plan, meet with the Contracting Officer and discuss the Contractor's quality control system. During the meeting, a mutual understanding of the system details must be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite work, and the interrelationship of Contractor's Management and control with the Government's Quality Assurance. Minutes of the meeting

will be prepared by the QC Manager and signed by the Contractor and the Government. Provide a copy of the signed minutes to all attendees and incorporate in the relevant QC Plan. At a minimum the Coordination and Mutual Understanding Meeting must be repeated when a new QC Manager is appointed. There can be other occasions when subsequent conferences will be called by either party to reconfirm mutual understandings or address deficiencies in the CQC system or procedures which can require corrective action by the Contractor.

1.5.1.2.1 Purpose

The purpose of this meeting is to develop a mutual understanding of the QC details, including documentation, administration for on-site and off-site work, design intent, Cx in accordance with Section 01 91 00.15 BUILDING COMMISSIONING, environmental requirements and procedures, coordination of activities to be performed, Special Inspections, and the coordination of the Contractor's management, production, and QC personnel. At the meeting, the Contractor must explain in detail how three phases of control will be implemented for each DFOW, as well as how each DFOW will be affected by each management plan or requirement as listed below:

a. Waste Management Plan.

b. Procedures for noise and acoustics management.

c. Environmental Protection Plan.

d. Environmental regulatory requirements.

e. Cx Plan requirements in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

f. Special Inspections.

g. Indoor Air Quality (IAQ) Management Plan.

h. Site Security and Access Management Plan (SSAMP) as defined by Section 01 14 00 WORK RESTRICTIONS.

1.5.1.2.2 Coordination of Activities

Coordinate activities included in various sections to assure efficient and orderly installation of each component. Coordinate operations included under different sections that are dependent on each other for proper installation and operation. Schedule construction operations with consideration for indoor air quality as specified in the IAQ Management Plan.Coordinate Special Inspections.

1.5.1.2.3 Attendees

As a minimum, the Contractor's personnel required to attend include an officer of the firm, the Project Manager, Project Superintendent, QC Manager, Alternate QC Manager, Special Inspector, Special Inspector of Record, Commissioning Provider (CxC), Environmental Manager, and subcontractor representatives. Each subcontractor who will be assigned QC responsibilities must have a principal of the firm at the meeting.

1.5.1.3 Quality Control (QC) Meetings

After the start of construction, conduct weekly QC meetings led by the QC Manager at the work site with the Project Superintendent, the Special Inspector, the Special Inspector of Record, CxC, and the other personnel as necessary. The QC Manager is to prepare the minutes of the meeting and provide a copy to the Contracting Officer within two working days after the meeting. The Contracting Officer may attend these meetings. As a minimum, accomplish the following at each meeting:

a. Review the minutes of the previous meeting.

b. Review the schedule and the status of work and deficiencies/rework. Review the most current approved schedule (in accordance with schedule specification) and the status of work and deficiencies/rework.

c. Review the status of submittals and Request For Information (RFIs).

d. Review the work to be accomplished in the next three weeks as defined by the schedule section paragraph WEEKLY PROGRESS MEETINGS in Section 01 32 01.00 10 PROJECT SCHEDULE and all documentation required for that work.

e. Review Testing Plan and Log including status of tests performed since last QC Meeting.

f. Resolve QC and production problems. Discuss status of pending change orders.

g. Address items that may require revising the QC Plan.

h. Review Accident Prevention Plan (APP) and effectiveness of the safety program.

i. Review environmental requirements and procedures.

j. Review Environmental Management Plan.

k. Review Waste Management Plan.

l. Review the status of training completion.

m. Review Cx Plan and progress. Review Issues Log and resolution.

n. Review IAQ Management Plan.

o. Review Site Security and Access Management Plan (SSAMP) as defined by Section 01 14 00 WORK RESTRICTIONS.

1.5.2 Contractor Quality Control (CQC) Plan

Submit no later than 30 calendar days after receipt of notice to proceed, the CQC Plan proposed to implement the requirements FAR 52.246-12 Inspection of Construction. The Government will consider an interim plan for the first 30 calendar days of operation. Construction will be permitted to begin only after acceptance of the CQC Plan and other Contract requirements or acceptance of an interim plan applicable to the particular feature of work to be started. Work outside of the accepted interim plan will not be permitted to begin until acceptance of a CQC Plan

or another interim plan containing the additional work.

1.5.2.1 Content of Contractor Quality Control (CQC) Plan

Provide a CQC Plan, prior to start of construction that includes a table of contents, with major sections identified, pages numbered sequentially, and that documents the proposed methods and responsibilities for accomplishing quality control during the construction of the project. The CQC Plan must at a minimum include the following sections:

a. A description of the quality control organization and acknowledgment that the CQC staff will implement the three phase control system for all aspects of the work specified. Include a CQC System Manager who reports to the Project Manager or another Quality Management Executive in the organization (not the Superintendent). Project Manager in this context means the individual with responsibility for the overall management of the project, including quality and production.

b. An organizational chart showing the quality control organization with individual names and job titles and lines of authority up to an executive of the company at the home office.

c. NAMES AND QUALIFICATIONS: Names and qualifications, in resume format, (including position titles and durations for qualifying experiences) for each person in the QC organization. Include the Construction Quality Management (CQM) for Contractors course certifications for the QC personnel as required by the paragraph CONSTRUCTION QUALITY MANAGEMENT TRAINING.

d. DUTIES, RESPONSIBILITY AND AUTHORITY OF QC PERSONNEL: Duties, responsibilities, and authorities of each person in the QC organization.

e. OUTSIDE ORGANIZATIONS: A listing of outside organizations, such as architectural and consulting engineering firms, that will be employed by the Contractor and a description of the services these firms will provide.

f. APPOINTMENT LETTERS: Letters signed by an officer of the firm appointing the QC Manager and Alternate QC Manager, CxC, and stating that they are responsible for implementing and managing the QC program as described in this Contract. Include in this letter the responsibility of the QC Manager and Alternate QC Manager to implement and manage the three phases of control, and their authority to stop work that is not in compliance with the Contract. Letters of direction are to be issued by the QC Manager to all other QC Specialists or quality control representatives outlining their duties, authorities, and responsibilities. Include copies of the letters in the QC Plan.

g. SUBMITTAL PROCEDURES AND INITIAL SUBMITTAL REGISTER: Procedures for reviewing, approving, scheduling, and managing submittals, including those of subcontractors, offsite fabricators, suppliers, and purchasing agents. Provide the name(s) of the person(s) in the QC organization authorized to review and certify submittals prior to approval. Provide the initial submittal of the Submittal Register as specified in Section 01 33 00 SUBMITTAL PROCEDURES.

h. TESTING LABORATORY INFORMATION: Testing laboratory information

required by the paragraph ACCREDITATION REQUIREMENTS, as applicable.

i. TESTING PLAN AND LOG: A Testing Plan and Log that includes the tests required, associated feature of work required, referenced by the specification paragraph number requiring the test, the frequency, and the person responsible for each test.

j. Procedures to complete construction deficiencies from identification through acceptable corrective action. Establish verification procedures that identified deficiencies have been corrected. This phase is performed prior to beginning work on each definable feature of work, after all required plans, documents, materials are approved, and after copies are at the work site.

k. Reporting procedures, including proposed reporting formats.

l. Procedures for submitting and reviewing design changes/variations prior to submission to the Contracting Officer.

m. LIST OF DEFINABLE FEATURES: A Definable Feature of Work (DFOW) is a task that is separate and distinct from other tasks and has control requirements and work crews unique to that task. A DFOW is identified by different trades or disciplines, or it is work by the same trade in a different environment. A DFOW is by definition any item or activity on the construction schedule, and the schedule specification provides direction regarding how the DFOWs are to be structured. Include in the list of DFOWs for all activities on the Construction Schedule. Although each section of the specifications can generally be considered as a definable feature of work, there are frequently more than one definable features under a particular section. Identify the specification section number and schedule activity ID for each DFOW listed. The DFOW list will be reviewed in coordination with the construction schedule and agreed upon during the Coordination of Mutual Understanding Meeting.

n. PROCEDURES FOR PERFORMING AND TRACKING THE THREE PHASES OF CONTROL: Identify procedures used to ensure the three phases of control to manage the quality on this project. For each Definable Feature of Work (DFOW), a Preparatory and Initial phase checklist will be filled out during the Preparatory and Initial phase meetings. Conduct the Preparatory and Initial Phases and meetings with a view towards obtaining quality construction by planning ahead and identifying potential problems for each DFOW.

o. Coordinate scheduled work with Special Inspections required by Section 01 45 35 SPECIAL INSPECTIONS, the Statement of Special Inspections and the Special Inspections Project Manual. Where the applicable code issued by the International Code Council (ICC) calls for inspections by the Building Official, the Contractor must include the inspections in the Quality Control Plan and must perform the inspections required by the applicable ICC. The Contractor must perform these inspections using independent qualified inspectors. Include the Special Inspections Project Manual requirements in the QC Plan.

p. PROCEDURES FOR COMPLETION INSPECTION: Procedures for identifying and documenting the completion inspection process. Include in these procedures the responsible party for punch out inspection, pre-final inspection, and final acceptance inspection.

q. TRAINING PROCEDURES AND TRAINING LOG: Procedures for coordinating and documenting the training of personnel required by the Contract.

r. ORGANIZATION AND PERSONNEL CERTIFICATIONS LOG: Procedures for coordinating, tracking and documenting all certifications required for entities such as subcontractors, testing laboratories, suppliers, and personnel. The QC Manager will ensure that certifications are current, appropriate for the work being performed, and will not lapse during any period of the Contract that the work is being performed.

1.5.3 Acceptance of the Quality Control (QC) Plan

The Contracting Officer's acceptance of the Contractor QC Plan, or interim plan applicable to the particular feature of work to be started, is required prior to the start of construction. The Government will consider an interim plan for the first 30 calendar days of operation. Work outside of the accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional work. The Contracting Officer reserves the right to require changes in the QC Plan and operations as necessary, including removal or addition of personnel, to ensure the specified quality of work. The Contracting Officer reserves the right to interview any member of the QC organization at any time to verify the submitted qualifications. All QC organization personnel are subject to acceptance by the Contracting Officer. The Contracting Officer may require the removal of any individual for non-compliance with quality requirements specified in the Contract.

1.5.4 Notification of Changes

Notify the Contracting Officer, in writing, of any proposed changes in the QC Plan or changes to the QC organization personnel. Proposed changes are subject to acceptance by the Contracting Officer.

1.5.5 Special Inspections

Perform all required Special Inspections per Section 01 45 35 SPECIAL INSPECTIONS, the statement of Special Inspections and the Schedule of Special Inspections.

1.6 QUALITY CONTROL (QC) ORGANIZATION

1.6.1 Personnel Requirements

The requirements for the CQC organization are a Site Safety and Health Officer (SSHO), QC Manager, and enough qualified personnel to ensure safety and Contract compliance. The SSHO reports directly to a senior project (or corporate) official independent from the QC Manager. The SSHO will also serve as a member of the CQC Staff Personnel identified in the technical provisions as requiring specialized skills to assure the required work is being performed properly. The CQC staff always maintains a presence at the site during progress of the work and have complete authority and responsibility to take any action necessary to ensure Contract compliance. The CQC staff will be subject to acceptance by the Contracting Officer. Provide adequate office space, filing systems and other resources as necessary to maintain an effective and fully functional CQC organization. Promptly complete and furnish all letters, material submittals, shop drawing submittals, schedules, and all other project documentation to the CQC organization. The CQC organization is responsible for always maintaining these documents and records at the

site, except as otherwise acceptable to the Contracting Officer.

1.6.2 Quality Control (QC) Manager

1.6.2.1 Duties

Provide a QC Manager at the work site to implement and manage the QC program. The QC Manager must be employed by the Prime Contractor. The only duties and responsibilities of the QC Manager are to manage and implement the QC program on this Contract. The QC Manager must attend the Coordination and Mutual Understanding Meeting, perform the three phases of control, perform submittal review and approval, ensure testing is performed and provide QC certifications and documentation required in this Contract. The QC Manager is responsible for managing and coordinating the three phases of control and documentation performed by testing laboratory personnel and any other inspection and testing personnel required by this Contract. The QC Manager is the manager of all QC activities. The QC manager is responsible for notifying the Special Inspector and Special Inspector of Record of activities which require their review. The QC manager is responsible for coordinating the Special Inspection activities, see paragraph CONTRACTOR'S QUALITY CONTROL (QC) MANAGER, in Section 01 45 35 SPECIAL INSPECTIONS.

1.6.2.2 Qualifications

The QC Manager must possess at least a Bachelor's degree in engineering, architecture, or construction management, with a current professional engineer registration or a current licensed architect and a minimum of 10 years construction experience as a Project Superintendent, QC Manager, Project Manager, Project Engineer or Construction Manager on similar size and type construction Contracts which included the major trades that are part of this Contract. The individual must have at least 2 years experience as a QC Manager. The individual must be familiar with the requirements of EM 385-1-1 and have experience in the areas of hazard identification, safety compliance, and sustainability.

The QC Manager and all members of the QC organization must be capable of reading, writing, and conversing fluently in the English language.

1.6.2.3 Construction Quality Management Training

In addition to the above experience and education requirements, the QC Manager, Alternate QC Manager, and Superintendent must have completed the CQM for Contractors course. If the QC Manager does not have a current certification, obtain the CQM for Contractors course certification within 90 days of award. This course is periodically offered by the Naval Facilities Engineering Systems Command and the Army Corps of Engineers. Contact the Contracting Officer for information on the next scheduled class.

The Construction Quality Management Training certificate expires after 5 years. If the QC Manager's certificate has expired, retake the course to remain current.

1.6.3 Organizational Changes

Maintain the QC staff with personnel as required by the specification section at all times. When it is necessary to make changes to the QC staff, revise the CQC Plan to reflect the changes and submit the changes

to the Contracting Officer for acceptance.

1.6.4 Alternate Quality Control (QC) Manager Duties and Qualifications

Designate an alternate for the QC Manager at the work site to serve in the event of the designated QC Manager's absence. The qualification requirements for the Alternate QC Manager must be the same as for the QC Manager.

1.6.5 Commissioning

Commissioning (Cx) is a systematic, quality-focused process for delivery of a project focusing on verifying and documenting all commissioned systems and assemblies are installed, tested, and operating as they were planned and designed to meet the project requirements. The Quality Control requirements outlined in this specification section are key in supporting the objectives of the Cx process, specifically coordinating testing, documenting, and verifying proper system operation. Properly executed the Quality Control support of Cx ensures timely execution of necessary tasks to deliver the fully commissioned and operating systems in coordination with the overall construction and project schedule.

Provide Cx in addition to the quality control requirements of this section and not as a substitute for quality control requirements. The QC Manager is responsible for carrying out the three phases of control while ensuring the functional performance and integrated systems tests are coordinated with the Cx provider as required for each system to be commissioned.

1.6.5.1 Certificate of Readiness

The QC Manager must issue a Certificate of Readiness for Government approval for each system to be commissioned. Schedule Functional Performance Tests for each system only after the Certificate of Readiness has been approved by the Government for the system. The Certificate of Readiness certifies that all required inspections have been completed and deficiencies that were identified through any prior review, inspection, or test activity have been corrected before the start of Functional Performance Tests. Refer to Cx requirements in Section 01 91 00.15 BUILDING COMMISSIONING for a list of systems to be commissioned and detailed requirements for the Cx provider.

1.6.6 Special Inspector and Special Inspector of Record

The Special Inspector (SI) and Special Inspector of Record (SIOR) must be an independent third party hired directly by the Prime Contractor. The SI and SIOR must not be a company employee of the Contractor or any subcontractor performing the work to be inspected. The qualifications of the SI and SIOR are defined in Section 01 45 35 SPECIAL INSPECTION.

1.6.7 Submittal Reviewers Duties and Qualifications

Provide Submittal Reviewers, other than the QC Manager or CxC, qualified in the disciplines being reviewed, to review and certify that the submittals meet the requirements of this Contract prior to certification or approval by the QC Manager.

Each submittal must be reviewed by a registered architect or professional engineer.

Each of the following submittals must be reviewed by individuals meeting the qualifications/experience specified below:

Qualification / Experience in Submittal Discipline	Submittals to be reviewed:	
	Section No	Submittal
Registered Mechanical Engineer	Division 22 & 23	All
Certified Information Assurance Manager Level II (IAM-II)	Division 25	All
Registered Electrical Engineer	Division 26, 27, & 28	All
Registered Structural Fabrication Engineer, (P.E.)	Section 05 12 00 STRUCTURAL STEEL	Drawings Erection Plan

1.7 SUBMITTAL AND DELIVERABLES REVIEW AND APPROVAL

Procedures for submission, review and approval of submittals are described in Section 01 33 00 SUBMITTAL PROCEDURES. Procedures must include field verification of relevant dimensions and component characteristics by the QC organization prior to submittal being sent to the Contracting Officer. The CQC organization is responsible for certifying that all submittals and deliverables are in compliance with the Contract. When Section 01 91 00.15 BUILDING COMMISSIONING are included in the Contract, the submittals required by those sections have to be coordinated with Section 01 33 00 SUBMITTAL PROCEDURES to ensure adequate time is allowed for each type of submittal required.

1.8 THREE PHASES OF CONTROL

CQC enables the Contractor to ensure that the construction, including that of subcontractors and suppliers, complies with the requirements of the Contract. At least three phases of control must be conducted by the QC Manager to adequately cover both on-site and off-site work for each definable feature of the construction work as follows:

1.8.1 Preparatory Phase

Document the results of the preparatory phase actions by separate minutes prepared by the QC Manager and attach to the daily CQC report. Instruct applicable workers as to the acceptable level of workmanship required to meet Contract specifications.

Notify the Contracting Officer at least two business days in advance of each preparatory phase meeting. The meeting will be conducted by the QC Manager and attended by the Project Superintendent, the CxC, the Special Inspector, the Special Inspector of Record, and the foreman responsible for the DFOW. When the DFOW will be accomplished by a subcontractor, that subcontractor's foreman must attend the preparatory phase meeting. This phase is performed prior to beginning work on each definable feature of work, after all required plans/documents/materials are approved/accepted, and after copies are at the work site. Perform the following prior to beginning work on each DFOW:

a. Review each paragraph of the applicable specification sections,

reference codes, and standards. Make available during the preparatory inspection a copy of those sections of referenced codes and standards applicable to that portion of the work to be accomplished in the field. Maintain and make available in the field for use by Government personnel until final acceptance of the work.

b. Review the Contract drawings.

c. Verify that field measurements are as indicated on construction or shop drawings or both before confirming product orders, to minimize waste due to excessive materials.

d. Verify that appropriate shop drawings and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required.

e. Review the testing plan and ensure that provisions have been made to provide the required QC testing.

f. Examine the work area to ensure that the required preliminary work has been completed and complies with the Contract and ensure any deficiencies/rework items in the preliminary work have been corrected and confirmed by the Contracting Officer.

g. Review coordination of product/material delivery to designated prepared areas to execute the work.

h. Examine the required materials, equipment and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data and are properly stored.

i. Check to assure that all materials and equipment have been tested, submitted, and approved.

j. Discuss specific controls to be used, construction methods, construction tolerances, workmanship standards, and the approach that will be used to provide quality construction by planning ahead and identifying potential problems for each DFOW. Ensure any portion of the plan requiring separate Contracting Officer acceptance has been approved.

k. Review the APP and appropriate Activity Hazard Analysis (AHA) to ensure that applicable safety requirements are met, and that required Safety Data Sheets (SDS) are submitted.

l. Review the Cx requirements in accordance with Section 01 91 00.15 BUILDING COMMISSIONING and ensure all preliminary work items have been completed and documented.

m. Discussion of procedures for controlling quality of the work including repetitive deficiencies. Document construction tolerances and workmanship standards for that feature of work.

n. Discuss schedule and execution of the initial control phase and confirmation or construction quality compliance.

o. Review Special Inspections required by Section 01 45 35 SPECIAL INSPECTION, the Statement of Special Inspections and the Schedule of Special Inspections.

1.8.2 Initial Phase

Notify the Contracting Officer at least two business days in advance of each initial phase. When construction crews are ready to start work on a DFOW, conduct the initial phase with the Project Superintendent, the Special Inspector, the Special Inspector of Record, and the foreman responsible for that DFOW. Observe the initial segment of the DFOW to ensure that the work complies with Contract requirements. Document the results of the initial phase in the daily CQC Report and in the Initial Phase Checklist. Repeat the initial phase for each new crew to work on-site when acceptable levels of specified quality are not being met. Indicate the exact location of initial phase for definable feature of work for future reference and comparison with follow-up phases. Perform the following for each DFOW:

a. Check work to ensure that it is in full compliance with Contract requirements. Review minutes of the preparatory meeting.

b. Verify adequacy of controls to ensure full Contract compliance. Verify required control inspection and testing comply with the Contract.

c. Establish level of workmanship and verify that it meets the minimum acceptable workmanship standards. Compare with required sample panels as appropriate.

d. Resolve any workmanship issues.

e. Ensure that testing is performed by the approved laboratory.

f. Check work procedures for compliance with the APP and the appropriate AHA to ensure that applicable safety requirements are met.

g. Review project specific work plans (i.e., Cx, HAZMAT Abatement, Stormwater Management) to ensure all preparatory work items have been completed and documented.

h. Coordinate scheduled work with Special Inspections required by Section 01 45 35 SPECIAL INSPECTIONS, the Statement of Special Inspections and the Schedule of Special Inspections.

1.8.3 Follow-Up Phase

Perform the following for on-going DFOW daily, or more frequently as necessary, until the completion of each DFOW. The Final Follow-Up for any DFOW will clearly note in the daily report the DFOW is completed, and all deficiencies/rework items have been completed in accordance with the paragraph DEFICIENCY/REWORK ITEMS LIST. Each DFOW that has completed the Initial Phase and has not completed the Final Follow-up must be included on each daily report. If no work was performed on that DFOW for the period of that daily report, it must be so noted. Document all Follow-Up activities for DFOWs in the daily CQC Report:

a. Ensure the work including control testing complies with Contract requirements until completion of that particular work feature. Record checks in the CQC documentation.

b. Maintain the quality of workmanship required.

c. Ensure that testing is performed by the approved laboratory.

d. Ensure that deficiencies/rework items are being corrected. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of work which may be affected by the deficient work.

e. Do not build upon nor conceal non-conforming work.

f. Assure manufacturers' representatives have performed necessary inspections if required and perform safety inspections.

g. Review the Cx requirements in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

h. Coordinate scheduled work with Special Inspections required by Section 01 45 35 SPECIAL INSPECTIONS, the Statement of Special Inspections and the Schedule of Special Inspections.

1.8.4 Additional Preparatory and Initial Phases

Conduct additional preparatory and initial phases on the same DFOW if the quality of on-going work is unacceptable, if there are changes in the applicable QC organization, if there are changes in the on-site production supervision or work crew, if work on a DFOW has not started within 45 days of the initial preparatory meeting or has resumed after 45 days of inactivity, or if other problems develop.

1.8.5 Notification of Three Phases of Control for Off-Site Work

Notify the Contracting Officer at least two weeks prior to the start of the preparatory and initial phases.

1.8.6 Deficiency/Rework Items List

The QC Manager must maintain a list of work that does not comply with the Contract, identifying what items need to be corrected, the activity ID number associated with the item, the date the item was originally discovered, the date the item will be corrected by, and the date the item was corrected.

The QC Manager reviews the list at each weekly QC Meeting:

a. There is no requirement to report a deficiency/rework item that is corrected the same day it is discovered.

b. No successor task may be advanced beyond the preparatory phase meeting until all deficiencies/rework items have been cleared by the QC Manager and concurred with by the Contracting Officer. This must be confirmed as part of the Preparatory Phase activities.

c. Attach a copy of the "Deficiency/Rework Items List" to the last daily CQC Report of each month.

d. The Contractor is responsible for including those items identified by the Contracting Officer.

e. All deficiencies/rework items must be confirmed as corrected by the QC

Manager, and concurred by the Contracting Officer, prior to commencement of any completion inspections per paragraph COMPLETION INSPECTIONS unless specifically exempted by the Contracting Officer.

f. Non-Compliance with these requirements is grounds for removal in accordance with paragraph ACCEPTANCE OF THE QUALITY CONTROL (QC) PLAN.

g. All delays, concurrent or related to failure to manage, monitor, control, and correct deficiencies/rework items are entirely the responsibility of the Contractor and cannot be made the subject, or any component of any request for additional time or compensation.

1.9 TESTING

Perform specified or required tests to verify that control measures are adequate to provide a product which conforms to Contract requirements. Upon request, furnish to the Government duplicate samples of test specimens for possible testing by the Government. Testing includes operation and acceptance tests when specified. Procure the services of an U.S. Army Corps of Engineers approved testing laboratory or establish an approved testing laboratory at the project site or at a nearby location as approved by the COR. Perform the following activities and record and provide the following data:

a. Verify that testing procedures comply with Contract requirements.

b. Verify that facilities and testing equipment are available and comply with testing standards.

c. Check test instrument calibration data against certified standards.

d. Verify that recording forms and test identification control number system, including all test documentation requirements, have been prepared.

e. Record results of all tests taken, both passing and failing on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test. If approved by the Contracting Officer, actual test reports are submitted later with a reference to the test number and date taken. Provide an information copy of tests performed by an offsite or commercial test facility directly to the Contracting Officer. Failure to submit timely test reports as stated results in nonpayment for related work performed and disapproval of the test facility for this Contract.

1.9.1 Laboratory Accreditation Authorities

All testing laboratories must be validated by the USACE Material Testing Center (MTC) for the tests to be performed. Information on the USACE MTC with web-links to both a list of validated testing laboratories and for the laboratory inspection request for can be found at: https://mtc.erdc.dren.mil

1.9.2 Capability Check

The Contracting Officer retains the right to check laboratory equipment in the proposed laboratory and the laboratory technician's testing procedures, techniques, and other items pertinent to testing, for

compliance with the standards set forth in this Contract. Laboratories utilized for testing soils, concrete, asphalt, and steel must meet criteria detailed in ASTM D3740 and ASTM E329.

1.9.2.1 Capability Recheck

If the selected laboratory fails the capability check, the Contractor will be assessed the actual cost of the recheck to reimburse the Government for each succeeding recheck of the laboratory or the checking of a subsequently selected laboratory. Such costs will be deducted from the Contract amount due the Contractor.

1.9.2.2 Onsite Laboratory

The Government reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests, and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Government.

1.9.3 Test Results

Cite applicable Contract requirements, tests or analytical procedures used. Provide actual results and include a statement that the item tested or analyzed conforms or fails to conform to specified requirements. If the item fails to conform, notify the Contracting Officer immediately. Conspicuously stamp the cover sheet for each report in large red letters "CONFORMS" or "DOES NOT CONFORM" to the specification requirements, whichever is applicable. Test results must be signed by a testing laboratory representative authorized to sign certified test reports. Furnish the signed reports, certifications, and other documentation to the Contracting Officer via the QC Manager.

1.10 COMPLETION INSPECTIONS

1.10.1 Punch-Out Inspection

Near the completion of all work or any increment thereof, established by a completion time stated in the Contract Clause entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the QC Manager must conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved drawings, specifications, and Contract. Include in the punch list any remaining items on the "Deficiency/Rework Items List", that were not corrected prior to the Punch-Out Inspection as approved by the Contracting Officer in accordance with the paragraph DEFICIENCY/REWORK ITEMS LIST. Include within the punch list the estimated date by which the deficiencies will be corrected. Provide a copy of the punch list to the Contracting Officer.

The QC Manager, or staff, must make follow-on inspections to ascertain that all deficiencies have been corrected. All punch list items must be confirmed as corrected by the QC Manager and concurred by the Contracting Officer. Once this is accomplished, notify the Government that the facility is ready for the Government "Pre-Final Inspection".

1.10.2 Pre-Final Inspection

The Government and QC Manager will perform this inspection to verify that the facility is complete and ready to be occupied. A Government

"Pre-Final Punch List" will be documented by the QC Manager as a result of this inspection. The QC Manager will ensure that all items on this list are corrected and concurred by the Contracting Officer prior to notifying the Government that a "Final" inspection with the Client can be scheduled. All items noted on the "Pre-Final" inspection must be corrected and concurred by the Contracting Officer in a timely manner and be accomplished before the Contract completion date for the work, or any increment thereof, if the project is divided into increments by separate completion dates unless exceptions are directed by the Contracting Officer.

1.10.3 Final Acceptance Inspection

Notify the Contracting Officer at least 14 calendar days prior to the date a final acceptance inspection can be held. State within the notice that all items previously identified on the pre-final punch list will be corrected and acceptable, along with any other unfinished Contract work, by the date of the final acceptance inspection. The Contractor must be represented by the QC Manager, the Project Superintendent, and others deemed necessary. Attendees for the Government will include the Contracting Officer, other Government QA personnel, and personnel representing the Client. Failure of the Contractor to have all Contract work acceptably complete for this inspection will be cause for the Contracting Officer to bill the Contractor for the Government's additional inspection cost in accordance with the Contract Clause entitled "Inspection of Construction."

1.11 QUALITY CONTROL (QC) CERTIFICATIONS

1.11.1 Contractor Quality Control (CQC) Report Certification

Contain the following statement within the CQC Report: "On behalf of the Contractor, I certify that this report is complete and correct and equipment and material used, and work performed during this reporting period is in compliance with the Contract drawings and specifications to the best of my knowledge, except as noted in this report."

1.11.2 Completion Certification

Upon completion of work under this Contract, the QC Manager must furnish a certificate to the Contracting Officer attesting that "the work has been completed, inspected, tested and is in compliance with the Contract." Provide a copy of this final QC Certification for completion to the preparer of the Operation & Maintenance (O&M) documentation.

1.12 DOCUMENTATION AND INFORMATION FOR THE CONTRACTING OFFICER

Maintain current and complete records of on-site and off-site QC program operations and activities.

Contact the Contracting Officer for sample forms or print from RMS-QCS as needed. Prior to commencing work on construction, the Contractor must obtain a copy set of the current report forms. The report forms will consist of the Contractor Quality Control (CQC) Report, CQC Report (Continuation Sheet), Contractor Production Report, Contractor Production Report (Continuation Sheet), Preparatory Phase Checklist, Initial Phase Checklist, Testing Plan and Log, and Rework Items List. Unless otherwise provided by the Contracting Officer, Contractor may use the forms provided as related material located at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-45-00.

1.12.1 Construction Documentation

Reports are required for each day that work is performed and must be attached to the Contractor Quality Control Report prepared for the same day. Maintain current and complete records of on-site and off-site QC program operations and activities. Reports are required for each day work is performed. Account for each calendar day throughout the life of the Contract.

The Project Superintendent and the QC Manager must prepare and sign the Contractor Production and CQC Reports, respectively. Every space on the forms must be filled in. Use N/A if nothing can be reported in one of the spaces. The reporting of work must be identified by terminology consistent with the construction schedule. In the "Remarks" sections of the reports, enter pertinent information including directions received, problems encountered during construction, work progress and delays, conflicts or errors in the drawings or specifications, field changes, safety hazards encountered, instructions given and corrective actions taken, delays encountered, a record of visitors to the work site, quality control problem areas, deviations from the QC Plan, construction deficiencies encountered, and meetings held. For each entry in the report(s), identify the Schedule Activity No. that is associated with the entered remark.

1.12.2 Quality Control Activities

CQC and Contractor Production reports will be prepared daily to maintain current records providing factual evidence that required quality control activities and tests have been performed. Include in these records the work of subcontractors and suppliers on an acceptable form that includes, as a minimum, the following information:

a. The name and area of responsibility of the Contractors and any subcontractors.

b. Operating plant/equipment with hours worked, idle, or down for repair.

c. Work performed each day, giving location, description, and by whom. When a Network Analysis Schedule (NAS) is used, identify each item of work performed each day by NAS activity number.

d. Control phase activities performed. Preparatory, and Initial phase Checklists associated with the DFOW referenced to the construction schedule. Follow-up phase activities identified to the DFOW. If testing or specific QC Specialist activities are associated with the Follow-up phase activities for a specific DFOW note this and include those reports.

e. Test and control activities performed with results and references to specifications and drawings requirements. Identify the control phase (Preparatory, Initial, Follow-up). List of deficiencies noted, along with corrective action in accordance with the paragraph DEFICIENCY/REWORK ITEMS LIST.

f. Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications and drawings requirements.

g. Submittals and deliverables reviewed, with Contract reference, by whom, and action taken.

h. Offsite surveillance activities, including actions taken.

i. Job safety evaluations stating what was checked, results, and instructions or corrective actions.

j. Instructions given/received and conflicts in plans and specifications.

1.12.3 Verification Statement

Indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. Cover both conforming and deficient features and include a statement that equipment and materials incorporated in the work and workmanship comply with the Contract.

Furnish the original and one copy of these records in report form to the Government by 10:00 AM the next working day after the date covered by the report. As a minimum, prepare and submit one report for every seven days of no work and on the last day of a no work period. All calendar days need to be accounted for throughout the life of the Contract. The first report following a day of no work will be for that day only. Reports need to be signed and dated by the QC Manager. Include copies of test reports and copies of reports prepared by all subordinate quality control personnel within the QC Manager Report.

1.12.4 Quality Control Validation

Establish and maintain the following in an electronic folder. Divide folder into a series of tabbed sections as shown below. Ensure folder is updated at each required progress meeting.

a. CQC Meeting minutes in accordance with paragraph QUALITY CONTROL (QC) MEETINGS.

b. All completed Preparatory and Initial Phase Checklists, arranged by specification section, further sorted by DFOW referenced to the construction schedule. Submit each individual Phase Checklist the day the phase event occurs as part of the CQC daily report.

c. All milestone inspections, arranged by Activity Number referenced to the construction schedule.

d. An up-to-date copy of the Testing Plan and Log with supporting field test reports, arranged by specification section referenced to the DFOW to which individual reports results are associated. Individual field test reports will be submitted within two working days after the test is performed in accordance with the paragraph QUALITY CONTROL ACTIVITIES.

e. Copies of all Contract modifications, arranged in numerical order. Also include documentation that modified work was accomplished.

f. An up-to-date copy of the paragraph DEFICIENCY/REWORK ITEMS LIST.

g. Cx documentation in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

h. Special Inspection reports.

i. Upon commencement of Completion Inspections of the entire project or any defined portion, maintain up-to-date copies of all punch lists issued by the QC staff to the Contractor and subcontractors and all punch lists issued by the Government in accordance with the paragraph COMPLETION INSPECTIONS.

1.12.5 Testing Plan and Log

As tests are performed, the CxC and the QC Manager will record on the "Testing Plan and Log" the date the test was performed and the date the test results were forwarded to the Contracting Officer. Attach a copy of the updated "Testing Plan and Log" to the last daily CQC Report of each month. Provide a copy of the final "Testing Plan and Log" to the preparer of the Operation & Maintenance (O&M) documentation.

1.12.6 As-Built Drawings

The QC Manager must ensure the as-built drawings, required by Section 01 78 39.00 24 AS-BUILT DRAWINGS are kept current on a daily basis and marked to show deviations which have been made from the Contract drawings. The as-built drawings document commences with the QC Manager ensuring all amendments, or changes to the Contract prior to Contract award are accurately noted in the initial document set creating the accurate baseline of the Contract prior to any work starting. Ensure each deviation has been identified with the appropriate modifying documentation (e.g., PC No., Modification No., Request for Information No.). The QC Manager must initial each revision. Upon completion of work, the QC Manager will furnish a certificate attesting to the accuracy of the as-built drawings prior to submission to the Contracting Officer.

1.13 NOTIFICATION ON NON-COMPLIANCE

The Contracting Officer will notify the Contractor of any detected non-compliance with the Contract. Take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, is deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders will be made the subject of a claim for extension of time for excess costs or damages by the Contractor.

1.14 DELIVERY, STORAGE, AND HANDLING

Designate receiving/storage areas for incoming material to be delivered according to installation schedule and to be placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. Store and handle materials in a manner as to prevent loss from weather and other damage. Keep materials, products, and accessories covered and off the ground, and store in a dry, secure area. Prevent contact with material that may cause corrosion, discoloration, or

staining. Protect all materials and installations from damage by the activities of other trades.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

CONTRACTOR PRODUCTION REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

DATE: Enter Date (DD/MMM/YY)

CONTRACT NO	TITLE AND LOCATION	REPORT NO
Enter Cnt# Here	Enter Title and Location of Construction Contract Here	Enter Report # Here

CONTRACTOR	SUPERINTENDENT
Enter The Contractor's Company Name Here	Enter Superintendent's Name Here

AM WEATHER	PM WEATHER	MAX TEMP (F)	MIN TEMP (F)
Enter AM Weather Data Here	Enter PM Weather Data Here	Enter Max Temp Here	Enter Min Temp Here

WORK PERFORMED TODAY

Schedule Activity No.	WORK LOCATION AND DESCRIPTION	EMPLOYER	NUMBER	TRADE	HRS

JOB SAFETY

			TOTAL WORK HOURS ON JOB SITE, THIS DATE, INCL CON'T SHEETS	
WAS A JOB SAFETY MEETING HELD THIS DATE? (If YES attach copy of the meeting minutes)	☐ YES	☐ NO		
WERE THERE ANY LOST TIME ACCIDENTS THIS DATE? (If YES attach copy of completed OSHA report)	☐ YES	☐ NO	CUMULATIVE TOTAL OF WORK HOURS FROM PREVIOUS REPORT	
WAS CRANE/MANLIFT/TRENCHING/SCAFFOLD/HV ELEC/HIGH WORK/ HAZMAT WORK DONE? (If YES attach statement or checklist showing inspection performed.)	☐ YES	☐ NO		
WAS HAZARDOUS MATERIAL/WASTE RELEASED INTO THE ENVIRONMENT? (If YES attach description of incident and proposed action.)	☐ YES	☐ NO	TOTAL WORK HOURS FROM START OF CONSTRUCTION	

Schedule Activity No.	LIST SAFETY ACTIONS TAKEN TODAY/SAFETY INSPECTIONS CONDUCTED	☐ SAFETY REQUIREMENTS HAVE BEEN MET.

EQUIPMENT/MATERIAL RECEIVED TODAY TO BE INCORPORATED IN JOB (INDICATE SCHEDULE ACTIVITY NUMBER)

Schedule Activity No.	Submittal #	Description of Equipment/Material Received

CONSTRUCTION AND PLANT EQUIPMENT ON JOB SITE TODAY. INDICATE HOURS USED AND SCHEDULE ACTIVITY NUMBER.

Schedule Activity No.	Owner	Description of Construction Equipment Used Today (incl Make and Model)	Hours Used

Schedule Activity No.	REMARKS

CONTRACTOR/SUPERINTENDENT _____ DATE _____

CONTRACTOR QUALITY CONTROL REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

DATE: Enter (DD/MMM/YY)

REPORT NO: Enter Rpt # Here

PHASE | CONTRACT NO: Enter Cnt# Here | CONTRACT TITLE: Enter Title and Location of Construction Contract Here

PREPARATORY

WAS PREPARATORY PHASE WORK PREFORMED TODAY? YES ☐ NO ☐

IF YES, FILL OUT AND ATTACH SUPPLEMENTAL PREPARATORY PHASE CHECKLIST.

Schedule Activity No.	Definable Feature of Work	Index #

INITIAL

WAS INITIAL PHASE WORK PREFORMED TODAY? YES ☐ NO ☐

IF YES, FILL OUT AND ATTACH SUPPLEMENTAL INITIAL PHASE CHECKLIST.

Schedule Activity No.	Definable Feature of Work	Index #

FOLLOW-UP

WORK COMPLIES WITH CONTRACT AS APPROVED DURING INITIAL PHASE? YES ☐ NO ☐

WORK COMPLIES WITH SAFETY REQUIREMENTS? YES ☐ NO ☐

Schedule Activity No.	Description of Work, Testing Performed & By Whom, Definable Feature of Work, Specification Section, Location and List of Personnel Present

REWORK ITEMS IDENTIFIED TODAY (NOT CORRECTED BY CLOSE OF BUSINESS)

Schedule Activity No.	Description

REWORK ITEMS CORRECTED TODAY (FROM REWORK ITEMS LIST)

Schedule Activity No.	Description

REMARKS (Also Explain Any Follow-Up Phase Checklist Item From Above That Was Answered "NO"), Manuf. Rep On-Site, etc.

Schedule Activity No.	Description

On behalf of the contractor, I certify that this report is complete and correct and equipment and material used and work performed during this reporting period is in compliance with the contract drawings and specifications to the best of my knowledge except as noted in this report.

AUTHORIZED QC MANAGER AT SITE DATE

GOVERNMENT QUALITY ASSURANCE REPORT

DATE

QUALITY ASSURANCE REPRESENTATIVE'S REMARKS AND/OR EXCEPTIONS TO THE REPORT

Schedule Activity No.	Description

GOVERNMENT QUALITY ASSURANCE MANAGER DATE

GOVERNMENT QUALITY ASSURANCE (QA) REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

DATE: Enter Date (DD/MMM/YY)

CONTRACT NO: Enter Cnt# Here

TITLE AND LOCATION: Enter Title and Location of Construction Contract Here

REPORT NO: Enter Report # Here

Status

WORKING?	YES	NO	IF NO, WHY NOT:
	☐	☐	

WEATHER CONDITIONS:

Check Points

	YES	NO	REMARKS:
SUPERINTENDENT ON SITE	☐	☐	
QC MANAGER ON SITE	☐	☐	
QC REPORTS CURRENT	☐	☐	
AS-BUILTS CURRENT	☐	☐	
SUBMITTALS APPROVED FOR FOR ONGOING WORK	☐	☐	
DEFICIENCY LIST REVIEWED	☐	☐	

WORK OBSERVED/DEFICIENCIES NOTED/SAFETY ISSUES DISCUSSED/QA TESTS AND RESULTS:

Schedule Activity No	DESCRIBE OBSERVATIONS

MEETING/CONFERENCE NOTES (INCLUDING PARTICIPANTS):

Schedule Activity No.	NOTES

INSTRUCTIONS GIVEN OR RECEIVED/CONTROVERSIES PENDING:

Schedule Activity No.	INSTRUCTIONS/CONTROVERSIES

QA REPRESENTATIVE DATE

SUPV INITIALS DATE

INITIAL PHASE CHECKLIST

SPEC SECTION	DATE
Enter Spec Section # Here	Enter Date (DD/MMM/YY)

CONTRACT NO	DEFINABLE FEATURE OF WORK	SCHEDULE ACT NO.	INDEX #
Enter Cnt# Here	Enter DFOW Here	Enter Sched Act ID Here	Enter Index# Here

PERSONNEL PRESENT

GOVERNMENT REP NOTIFIED _____ HOURS IN ADVANCE: YES ☐ NO ☐

NAME	POSITION	COMPANY/GOVERNMENT

PROCEDURE COMPLIANCE

IDENTIFIY FULL COMPLIANCE WITH PROCEDURES IDENTIFIED AT PREPARATORY. COORDINATE PLANS, SPECIFICATIONS, AND SUBMITTALS.

COMMENTS:

PRELIMINARY WORK

ENSURE PRELIMINARY WORK IS COMPLETE AND CORRECT. IF NOT, WHAT ACTION IS TAKEN?

WORKMANSHIP

ESTABLISH LEVEL OF WORKMANSHIP.

WHERE IS WORK LOCATED?

IS SAMPLE PANEL REQUIRED? YES ☐ NO ☐

WILL THE INIITAL WORK BE CONSIDERED AS A SAMPLE? YES ☐ NO ☐

(IF YES, MAINTAIN IN PRESENT CONDITION AS LONG AS POSSIBLE AND DESCRIBE LOCATION OF SAMPLE)

RESOLUTION

RESOLVE ANY DIFFERENCES.

COMMENTS:

CHECK SAFETY

REVIEW JOB CONDITIONS USING EM 385-1-1 AND JOB HAZARD ANALYSIS

COMMENTS:

OTHER

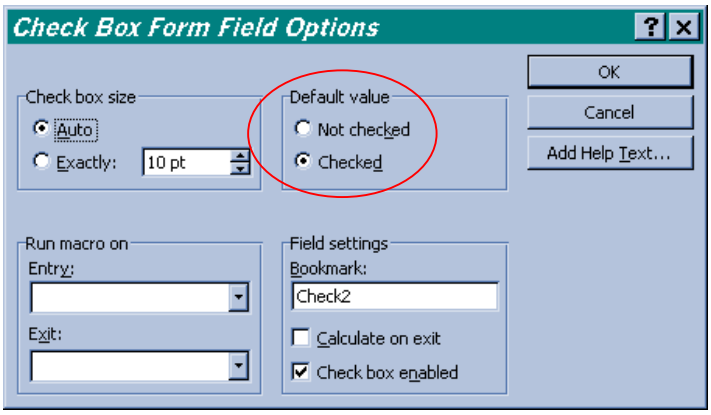
OTHER ITEMS OR REMARKS

QC MANAGER DATE

Instructions for Using Report Forms in MS-Word

In the Report Header, fields that have instructional text such as "Enter Title and Location of Construction Contract Here" prompt the user to enter the information in a specific location, governed by the field. Single mouse click anywhere in the field and the field will darken. Entry of text/data at this point will delete the instructional text in the field and will be replaced with entered text/data.

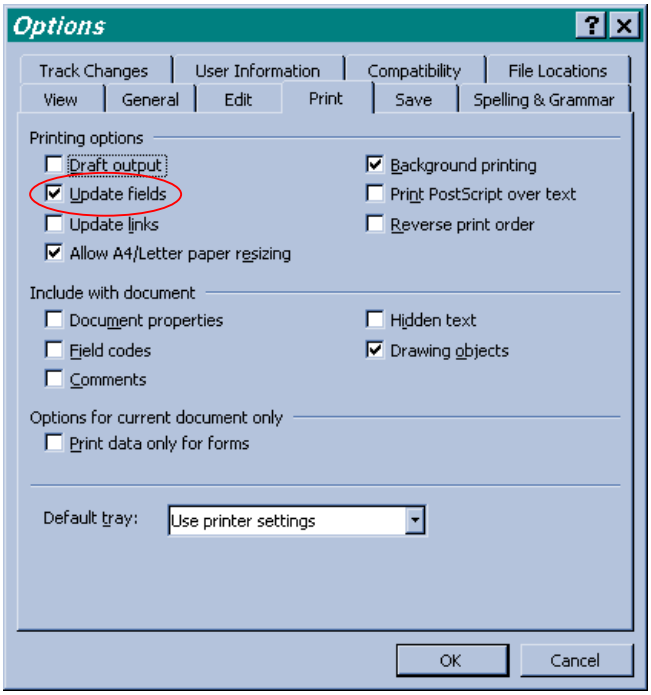
All check boxes are all defaulted as unchecked (i.e.; ☐). To check the box (i.e.; ☒), double click the box and the "Check Box Form Field Options" box will appear. In the "Default value" section of the box, click in the Radio Button for "Checked", then click on the "OK" button and the box will be checked.



The "Hour" fields where intentionally not programmed to total. If the Contractor deleted the formula in a field within the range that was to be totaled, the total would be wrong.

With the ability to [unlimitedly] expand the Contractor Production Report and Contractor Quality Control Representative Report, their Continuation Sheets are obsolete.

In the footer of each form are data fields for the Sheet number and the total number of sheets in the report (Sheet 1 of 2). The first number will generate itself when pages of the report are added. But MS-Word will not automatically update the second number. To update the NumPages field, click the field or the field results and then press F9. You can also click **Options** in the **Tools** menu, click the **Print** tab, and then select the **Update fields** check box.



PREPARATORY PHASE CHECKLIST

(CONTINUED ON SECOND PAGE)

SPEC SECTION	DATE
Enter Spec Section # Here	Enter Date (DD/MMM/YY)

CONTRACT NO	DEFINABLE FEATURE OF WORK	SCHEDULE ACT NO.	INDEX #
Enter Cnt# Here	Enter DFOW Here	Enter Sched Act ID Here	Enter Index# Here

PERSONNEL PRESENT

GOVERNMENT REP NOTIFIED _____ HOURS IN ADVANCE: YES ☐ NO ☐

NAME	POSITION	COMPANY/GOVERNMENT

SUBMITTALS

REVIEW SUBMITTALS AND/OR SUBMITTAL REGISTER. HAVE ALL SUBMITTALS BEEN APPROVED? YES ☐ NO ☐

IF NO, WHAT ITEMS HAVE NOT BEEN SUBMITTED?

ARE ALL MATERIALS ON HAND? YES ☐ NO ☐

IF NO, WHAT ITEMS ARE MISSING?

CHECK APPROVED SUBMITTALS AGAINST DELIVERED MATERIAL. (THIS SHOULD BE DONE AS MATERIAL ARRIVES.)

COMMENTS:

MATERIAL STORAGE

ARE MATERIALS STORED PROPERLY? YES ☐ NO ☐

IF NO, WHAT ACTION IS TAKEN?

SPECIFICATIONS

REVIEW EACH PARAGRAPH OF SPECIFICATIONS.

DISCUSS PROCEDURE FOR ACCOMPLISHING THE WORK.

CLARIFY ANY DIFFERENCES.

PRELIMINARY WORK & PERMITS

ENSURE PRELIMINARY WORK IS CORRECT AND PERMITS ARE ON FILE.

IF NOT, WHAT ACTION IS TAKEN?

TESTING

IDENTIFY TEST TO BE PERFORMED, FREQUENCY, AND BY WHOM.

WHEN REQUIRED?

WHERE REQUIRED?

REVIEW TESTING PLAN.

HAS TEST FACILITIES BEEN APPROVED?

SAFETY

ACTIVITY HAZARD ANALYSIS APPROVED? YES ☐ NO ☐

REVIEW APPLICABLE PORTION OF EM 385-1-1.

MEETING COMMENTS

NAVY/ROICC COMMENTS DURING MEETING.

OTHER ITEMS OR REMARKS

OTHER ITEMS OR REMARKS:

QC MANAGER DATE

RESPONSIBILITIES/AUTHORITY OF THE QC MANAGER

1. Appointing letter to the QC manager shall detail his/her authority and responsibility to act for the contractor and outline his/her duties, responsibilities and authority. He/she shall have no job-related responsibilities other than QC unless specifically permitted in the specification.

2. He/she shall be on the site at all times during progress of the work, with complete authority to take any action necessary to ensure conformance with the contract requirements. In the event of his/her absence, approved backup shall be on the site.

3. Authority to immediately stop any segment of work which does not comply with the contract plans and specifications and direct the removal and replacement of any defective work.

4. Conduct daily inspection of work performed for compliance with plans and specifications.

5. Certify daily that all materials and equipment delivered/installed in the work comply with contract plans and specifications. Certify daily that all work performed on the construction site and off the construction site conforms to plans and specifications. Report any deficiencies and remedial action planned and taken.

6. Supervise and coordinate the inspection and tests made by the members of the Quality Control Organization, including subcontractors.

7. Assure QC staff is adequate to meet its responsibilities.

8. Maintain a copy of the ROICC approved QC Plan on file at the jobsite complete with up-to-date approved revisions/filled-in log of submittals. Maintain at the jobsite an
up-to-date QC Submittal Register (provided in the specification) showing the status of all submittals required by the contract.

9. Maintain at the jobsite a testing plan showing status of all tests required by the contracts. Ensure that all tests required are performed and report the results of same. Indicate whether test results show the item tested conforms to contract requirements or not.

10. Authority to remove any individual from the site who fails to perform his/her work in a skillful and workmanlike manner or his/her work does not comply with the contract plans and specifications.

11. QC manager does not have authority to deviate from plans and specifications without prior approval, in writing, from the ROICC.

12. Ensure that the contractor's Quality Control Organization is adequately staffed with qualified personnel to perform all the detailed inspections and testing specified in the plans and specifications.

13. Maintain at the jobsite the up-to-date QC Rework Items List.

ATTACHMENT A

REWORK ITEMS LIST

Contract No. and Title: Enter Contract # and Title Here

Contractor: Enter Contractor's Company Name Here

NUMBER	DATE IDENTIFIED	DESCRIPTION	CONTRACT REQUIREMENT (Spec. Section and Par. No., Drawing No. and Detail No., etc.)	ACTION TAKEN BY QC MANAGER	RESOLUTION	DATE COMPLETED

TESTING PLAN AND LOG

CONTRACT NUMBER Enter Contract # Here			PROJECT TITLE AND LOCATION Enter Contract Title and Location Here							CONTRACTOR Enter Contractor's Company Name Here	
SPECIFICATION SECTION AND PARAGRAPH NUMBER	ITEM OF WORK	TEST REQUIRED	ACCREDITED/ APPROVED LAB		SAMPLED BY	TESTED BY	LOCATION OF TEST		DATE COMPLETED	DATE FORWARDED TO CONTR. OFF.	REMARKS
			YES	NO			ON SITE	OFF SITE			

4296/4 (9/98) SHEET 1

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SECTION 01 45 00.15 10

RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE (RMS CM)

11/23

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SECTION 01 45 00.15 10

RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE (RMS CM)
11/23

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 MEASUREMENT AND PAYMENT

The work of this section is not measured for payment. The Contractor is responsible for the work of this section, without any direct compensation other than the payment received for contract items.

1.3 CONTRACT ADMINISTRATION

The Government will use the Resident Management System (RMS) to assist in its monitoring and administration of this contract. The Government accesses the system using the Government Mode of RMS (RMS GM) and the Contractor accesses the system using the Contractor Mode (RMS CM). The term RMS will be used in the remainder of this section for both RMS GM and RMS CM. The joint Government-Contractor use of RMS facilitates electronic exchange of information and overall management of the contract. The Contractor accesses RMS to record, maintain, input, track, and electronically share information with the Government throughout the contract period in the following areas:

Administration
Finances
Quality Control
Submittal Monitoring
Scheduling
Closeout
Import/Export of Data

The Contractor must be prepared to transition from the Resident Management System (RMS) to the new Construction Management Platform (CMP) at any time during the period of performance of this contract, once the USACE enterprise implements this change. The Contractor's obligation to transition from RMS to the CMP system is a requirement of this contract. Therefore, additional time or cost increase to complete this transition will not be considered. In the event of the transition, RMS project information will be migrated to CMP by the government and available in the CMP system. After the transition, the Contractor must utilize the CMP system to perform all contract administration functions previously required in RMS, including all areas listed above. After the transition, “RMS” and “CMP” will be synonymous for all “Resident Management System”

and “RMS” references in this contract’s specification. To facilitate the transition from RMS to CMP, online training for the CMP system will be made available to the Contractor with enough time to train staff, prior to the transition occurring.

1.3.1 Correspondence and Electronic Communications

For ease and speed of communications, exchange correspondence and other documents in electronic format to the maximum extent feasible. Some documents such as correspondence, including pay requests and payrolls, may be required in paper format with original signatures. Paper documents will govern in the event of discrepancy with the electronic version. Contracting Officer will determine which documents require submission of paper copies.

1.3.2 Other Factors

Other portions of this document have a direct relationship to the reporting accomplished through RMS. Particular attention is directed to FAR 52.236-15 Schedules for Construction Contracts; FAR 52.232-27 Prompt Payment for Construction Contracts; FAR 52.232-5 Payments Under Fixed-Priced Construction Contracts; Section 01 32 01.00 10 PROJECT SCHEDULE; Section 01 33 00 SUBMITTAL PROCEDURES; Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS; and Section 01 45 00 QUALITY CONTROL.

1.4 RMS SOFTWARE

RMS is a web based application. Download, install and be able to utilize the latest version of RMS within 7 calendar days of receipt of the Notice to Proceed. RMS software, user manuals, access and installation instructions, program updates and training information are available from the RMS website (https://rms.usace.army.mil). The Government and the Contractor will have different access authorities to the same contract database through RMS. The common database will be updated automatically each time a user finalizes an entry or change.

1.5 CONTRACT DATABASE - GOVERNMENT

The Government will enter the basic contract award data in RMS prior to granting the Contractor access. The Government entries into RMS will generally be related to submittal reviews, correspondence status, and Quality Assurance(QA)comments, as well as other miscellaneous administrative information.

1.6 CONTRACT DATABASE - CONTRACTOR

Contractor entries into RMS establish, maintain, and update data throughout the duration of the contract. Contractor entries generally include prime and subcontractor information, daily reports, submittals, RFI's, schedule updates and payment requests. RMS includes the ability to import attachments and export reports in many of the modules, including submittals. The Contractor responsibilities for entries in RMS typically include the following items:

1.6.1 Administration

1.6.1.1 Contractor Information

Enter all current Contractor administrative data and information into RMS

within 7 calendar days of receiving access to the contract in RMS. This includes, but is not limited to, Contractor's name, address, telephone numbers, management staff, and other required items.

1.6.1.2 Subcontractor Information

Enter all missing subcontractor administrative data and information into RMS CM within seven calendar days of receiving access to the Contract in RMS or within seven calendar days of the signing of the subcontractor agreement for agreements signed at a later date. This includes name, trade, address, phone numbers, and other required information for all subcontractors. A subcontractor is listed separately for each trade to be performed.

1.6.1.3 Correspondence

Identify all Contractor correspondence to the Government with a serial number. Prefix correspondence initiated by the Contractor's site office with "S". Prefix letters initiated by the Contractor's home (main) office with "H". Letters are numbered starting from 0001. (e.g., H-0001 or S-0001). The Government's letters to the Contractor will be prefixed with "C" or "RFP".

1.6.1.4 Equipment

Enter and maintain a current list of equipment planned for use or being used on the jobsite, including the most recent and planned equipment inspection dates in accordance with Section 01 45 00 QUALITY CONTROL.

1.6.1.5 Reports

Track the status of the project using the reports available in RMS. The value of these reports reflects the quality of the data input. These reports include but are not limited to the Progress Payment Request worksheet, Quality Control (QC) comments, Deficiency Tracking Log, Submittal Register Status, and Three-Phase Control worksheets in accordance with Sections Section 01 32 01.00 10 PROJECT SCHEDULE, 01 33 00 SUBMITTAL PROCEDURES, and 01 45 00 QUALITY CONTROL.

1.6.1.6 Request For Information (RFI)

Create and track all Requests For Information (RFI) in the RMS Administration Module for Government review and response. Provide status at weekly progress meeting in accordance with Section 01 32 01.00 10 PROJECT SCHEDULE.

1.6.2 Finances

1.6.2.1 Pay Activity Data

Develop and enter a list of pay activities in conjunction with the project schedule in accordance with Section 01 32 01.00 10 PROJECT SCHEDULE. The sum of pay activities equals the total Contract amount, including modifications. Each pay activity must be assigned to a Contract Line Item Number (CLIN). The sum of the activities assigned to a CLIN equals the amount of each CLIN.

1.6.2.2 Payment Requests

Prepare all progress payment requests using RMS. Update the work completed under the Contract at least monthly, measured as percent or as specific quantities. After the update, generate a payment request and prompt payment certification using RMS. Submit the signed prompt payment certification and payment request as well as supporting data, either electronically or by hard copy.

1.6.3 Quality Control (QC)

Enter and track implementation of the 3-phase QC Control System, QC testing, transferred and installed property and warranties in RMS. Prepare daily reports, identify and track deficiencies, document progress of work, and support other Contractor QC requirements in RMS. Maintain all data on a daily basis. Ensure that RMS reflects all quality control methods, tests and actions contained within the Contractor Quality Control (CQC) Plan and Government review comments. Provide within seven calendar days of Government acceptance of the CQC Plan.

1.6.3.1 Quality Control (QC) Reports

The Contractor's Quality Control (QC) Daily Report in RMS is the official report. The Contractor can use other supplemental formats to record QC data, but information from any supplemental formats are to be consolidated and entered into the RMS QC Daily Report. Any supplemental information may be entered into RMS as an attachment to the report. QC Daily Reports must be finalized and signed in RMS within 24 hours after the date covered by the report. Provide the Government a printed signed copy of the QC Daily Report, unless waived by the Contracting Officer.

1.6.3.2 Deficiency Tracking.

Use the QC Daily Report Module to enter and track deficiencies. Deficiencies identified and entered into RMS by the Contractor or the Government will be sequentially numbered with a QC or QA prefix for tracking purposes. Enter each deficiency into RMS the same day that the deficiency is identified. Monitor, track and resolve all QC and QA entered deficiencies. A deficiency is not considered to be corrected until the Government indicates concurrence in RMS.

1.6.3.3 Three-Phase Control Meetings

Maintain scheduled and actual dates and times of preparatory and initial control meetings in RMS, and upload meeting minutes of the meetings. Worksheets for the three-phase control meetings are generated within RMS.

1.6.3.4 Labor and Equipment Hours

Enter labor and equipment exposure hours on a daily basis. Roll up the labor and equipment exposure data into a monthly exposure report.

1.6.3.5 Accident/Safety Reporting

Both the Contractor and the Government enter safety related comments in RMS as a deficiency. The Contractor must monitor, track and show resolution for safety issues in the QC Daily Report area of the RMS QC Module. In addition, follow all reporting requirements for accidents and incidents as required in EM 385-1-1, Section 01 35 26 GOVERNMENTAL SAFETY

REQUIREMENTS and as required by any other applicable Federal, State or local agencies.

1.6.3.6 Definable Features of Work

Enter each feature of work, as defined in the approved CQC Plan, into the RMS QC Module. A feature of work may be associated with a single or multiple pay activities, however a pay activity is only to be linked to a single feature of work.

1.6.3.7 Activity Hazard Analysis

Import activity hazard analysis electronic document files into the RMS QC Module utilizing the document package manager. Prepare activity hazard analysis in accordance with Section 01 35 26 GOVERNMENT SAFETY REQUIREMENTS.

1.6.4 Submittal Management

Enter all current submittal register data and information into RMS within seven calendar days of receiving access to the Contract in RMS. Contractor is responsible for entering Activity Numbers for each submittal item corresponding to their Schedule. The Contractor will import the information shown in the submittal register following the specification Section 01 33 00 SUBMITTAL PROCEDURES unless otherwise directed by the Contracting Officer. Group electronic submittal documents into transmittal packages to send to the Government, except very large electronic files, samples, spare parts, mock ups, color boards, or where hard copies are specifically required. Track transmittals and update the submittal register in RMS on a daily basis throughout the duration of the Contract. Submit hard copies of all submittals unless waived by the Contracting Officer.

Contractor may request submittals to be added to RMS throughout the lifecycle of the project. Approval/disapproval of Contractor requests is at the discretion of the Contracting Officer. Submittals entry into RMS must be updated daily or as practical for performance of the Contract, as approved by the Contracting Officer.

1.6.5 Schedule

Develop a construction schedule consisting of pay activities, in accordance with Section 01 32 01.00 10 PROJECT SCHEDULE. Enter and update the contract project schedule in RMS by either manually entering all schedule data or by importing the Standard Data Exchange Format (SDEF) file. Include with each pay request the updated schedule. Provide electronic copies of transmittals.

1.6.6 Closeout

Closeout documents, processes and forms are managed and tracked in RMS by both the Contractor and the Government. Ensure that all closeout documents are entered, completed and documented within RMS.

1.7 IMPLEMENTATION

Use of RMS as described in the preceding paragraphs is mandatory. Ensure that sufficient resources are available to maintain contract data within the RMS system. RMS is an integral part of the Contractor's required

management of quality control.

1.8 NOTIFICATION OF NONCOMPLIANCE

Take corrective action within seven calendar days after receipt of notice of RMS non-compliance by the Contracting Officer.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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SECTION 01 45 35

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-- End of Section Table of Contents --

SECTION 01 45 35

SPECIAL INSPECTIONS
02/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2017) Minimum Design Loads for Buildings and Other Structures

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

1.2 GENERAL REQUIREMENTS

Perform Special Inspections in accordance with the Statement of Special Inspections, Schedule of Special Inspections and Chapter 17 of ICC IBC. The Statement of Special Inspections and Schedule of Special Inspections are included in the construction documents. Special Inspections are to be performed by an independent third party and are intended to ensure that the work of the prime contractor is in accordance with the Contract Documents and applicable building codes. Special inspections do not take the place of the three phases of control inspections performed by the Contractor's QC Manager or any testing and inspections required by other sections of the specifications.

1.3 DEFINITIONS

1.3.1 Continuous Special Inspections

Continuous Special Inspections is the constant monitoring of specific tasks by a special inspector. These inspections must be carried out continuously over the duration of the particular tasks.

1.3.2 Periodic Special Inspections

Periodic Special Inspections is Special Inspections by the special inspector who is intermittently present where the work to be inspected has been or is being performed.

1.3.3 Perform

Perform these Special Inspections tasks for each welded joint or member.

1.3.4 Observe

Observe these Special Inspections items on a random daily basis.

Operations need not be delayed pending these inspections.

1.3.5 Special Inspector (SI)

A qualified person retained by the contractor and approved by the Contracting Officer as having the competence necessary to inspect a particular type of construction requiring Special Inspections. The SI must be an independent third party hired directly by the Prime Contractor.

1.3.6 Associate Special Inspector (ASI)

A qualified person who assists the SI in performing Special Inspections but must perform inspection under the direct supervision of the SI and cannot perform inspections without the SI on site.

1.3.7 Third Party

A third party inspector must not be company employee of the Contractor or any Sub-Contractor performing the work to be inspected.

1.3.8 Special Inspector of Record (SIOR)

A licensed engineer in responsible charge of supervision all special inspectors for the project and approved by the Contracting officer. The SIOR must be an independent third party hired directly by the Prime Contractor.

1.3.9 Contracting Officer

The Government official having overall authority for administrative contracting actions. Certain contracting actions may be delegated to the Contracting Officer's Representative (COR).

1.3.10 Contractor's Quality Control (QC) Manager

An individual retained by the prime contractor and qualified in accordance with the Section 01 45 00 QUALITY CONTROL having the overall responsibility for the contractor's QC organization.

1.3.11 Designer of Record (DOR)

A registered design professional contracted by the Government as an A/E responsible for the overall design and review of submittal documents prepared by others. The DOR is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws in state in which the design professional works. The DOR is also referred to as the Engineer of Record (EOR) in design code documents.

1.3.12 Schedule of Special Inspections

A schedule which lists each of the required Special Inspections, the extent to which each Special Inspections is to be performed, and the required frequency for each in accordance with ICC IBC Chapter 17.

1.3.13 Designated Seismic System

Those nonstructural components that require design in accordance with ASCE 7 Chapter 13 and for which the component importance factor, Ip, is

greater than 1.0. This designation applies to systems that are required to be operational following the Design Earthquake for RC I - IV structures.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

SIOR Letter of Acceptance; G, RO
Special Inspections Project Manual; G, RO
NDT Procedures and Equipment Calibration Records

SD-06 Test Reports

Special Inspections Daily ReportsSpecial Inspections Biweekly Reports

SD-07 Certificates

Fabrication Plant
Steel Joist Institute Membership
Precast Concrete Institute (PCI) Certified Plant
Certificate of Compliance
Special Inspector of Record Qualifications
Special Inspector Qualifications
Qualification Records for NDT technicians

SD-11 Closeout Submittals

Comprehensive Final Report of Special Inspections; G, RO

1.5 SPECIAL INSPECTOR QUALIFICATIONS

Submit qualifications for each special inspector and the special inspector of record.

Certifying Associations	
AABC	Associated Air Balance Council
ACI	American Concrete Institute
AWS	American Welding Society
ICC	International Code Council
NDT	Nondestructive Testing
NICET	National Institute for Certification in Engineering Technologies
PCI	Precast/Prestressed Concrete Institute

Certifying Associations	
UL	Underwriters Laboratories

1.5.1 Steel Construction and High Strength Bolting

1.5.1.1 Special Inspector

a. ICC Structural Steel and Bolting Special Inspector certificate with one year of related experience, or

b. Registered Professional Engineer with related experience

1.5.1.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.2 Welding Structural Steel

1.5.2.1 Special Inspector

a. ICC Structural Welding Special Inspector certificate with one year of related experience, or

b. AWS Certified Welding Inspector

1.5.2.2 Associate Special Inspector

AWS Certified Associate Welding Inspector

1.5.3 Nondestructive Testing of Welds

1.5.3.1 Special Inspector

NDT Level III Certificate

1.5.3.2 Associate Special Inspector

NDT Level II Certificate plus one year of related experience

1.5.4 Cold Formed Steel Framing

1.5.4.1 Special Inspector

a. ICC Structural Steel and Bolting Special Inspector certificate with one year of related experience, or

b. ICC Commercial Building Inspector with one year of experience, or

c. ICC Residential Building Inspector with one year of experience, or

d. Registered Professional Engineer with related experience

1.5.4.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.5 Concrete Construction

1.5.5.1 Special Inspector

a. ICC Reinforced Concrete Special Inspector Certificate with one year of related experience, or

b. ACI Concrete Construction Special Inspector, or

c. NICET Concrete Technician Level III Certificate in Construction Materials Testing, or

d. Registered Professional Engineer with related experience

1.5.5.2 Associate Special Inspector

a. ACI Concrete Construction Special Inspector in Training, or

b. Engineer-In-Training with one year of related experience

1.5.6 Prestressed Concrete Construction

1.5.6.1 Special Inspector

a. ICC Pre-stressed Special Inspector Certificate with one year of related experience, or

b. PCI Quality Control Technician/ Inspector Level II Certificate with one year of related experience, or

c. Registered Professional Engineer with related experience

1.5.6.2 Associate Special Inspector

a. PCI Quality Control Technician/ Inspector Level I Certificate with one year of related experience, or

b. Engineer-In-Training with one year of related experience

1.5.7 Verification of Site Soil Condition, Fill Placement and Load-Bearing Requirements

1.5.7.1 Special Inspector

a. ICC Soils Special Inspector Certificate with one year of related experience, or

b. NICET Soils Technician Level II Certificate in Construction Material Testing, or

c. NICET Geotechnical Engineering Technician Level II Construction or Generalist Certificate, or

d. Geologist-In-Training with one year of related experience, or

e. Registered Professional Engineer with related experience

1.5.7.2 Associate Special Inspector

a. NICET Soils Technician Level I Certificate in Construction Material Testing with one year of related experience, or

b. NICET Geotechnical Engineering Technician Level I Construction or Generalist Certificate with one year of related experience, or

c. Engineer-In-Training with one year of related experience

1.5.8 Smoke Control

1.5.8.1 Special Inspector

a. AABC Technician Certification with one year of related experience, or

b. Registered Professional Engineer with related experience

1.5.8.2 Associate Special Inspector

Engineer-In-Training with one year of related experience.

1.5.9 Special Inspector of Record (SIOR)

Registered Professional Engineer

PART 2 PRODUCTS

2.1 FABRICATOR SPECIAL INSPECTIONS

Special Inspections of fabricator's work performed in the fabricator's shop is required to be inspected in accordance with the Statement of Special Inspections and the Schedule of Special Inspections unless the fabricator is certified by the approved agency to perform such work without Special Inspections. Submit the following certifications to the Contracting Officer for information to allow work performed in the fabricator's shop to not be subjected to Special Inspections.

American Institute of Steel Construction (AISC) Certified Fabrication Plant, Category STD.
Steel Joist Institute Membership
Precast Concrete Institute (PCI) Certified Plant, Group C

At the completion of fabrication, submit a certificate of compliance, to be included with the comprehensive final report of Special Inspections, stating that the materials supplied and work performed by the fabricator are in accordance the construction documents.

PART 3 EXECUTION

3.1 RESPONSIBILITIES

3.1.1 Special Inspector of Record

a. Supervise all Special Inspectors required by the contract documents and the IBC.

b. Submit a SIOR Letter of Acceptance to the Contracting Officer attesting to acceptance of the duties of SIOR, signed and sealed by

the SIOR.

c. Verify the qualifications of all of the Special Inspectors.

d. Verify the qualifications of fabricators.

e. Submit qualification records for nondestructive testing (NDT) technicians designated for the project.

f. Submit NDT procedures and equipment calibration records for NDT to be performed and equipment to be used for the project.

g. Prepare a Special Inspections Project Manual, which will cover the following:

(1) Roles and responsibilities of the following individuals during Special Inspections: SIOR, SI, General Contractor, Subcontractors, QC Manager, and DOR.

(2) Organizational chart and/or communication plan, indicating lines of communication.

(3) Contractor's internal plan for scheduling inspections. Address items such as timeliness of inspection requests, who to contact for inspection requests, and availability of alternate inspectors.

(4) Indicate the government reporting procedures.

(5) Propose forms or templates to be used by SI and SIOR to document inspections.

(6) Indicate procedures for tracking nonconforming work and verification that corrective work is complete.

(7) Indicate how the SIOR and/or SI will participate in weekly QC meetings.

(8) Indicate how Special Inspections of shop fabricated items will be handled when the fabricator's shop is not certified per paragraph FABRICATOR SPECIAL INSPECTIONS.

(9) Include a section in the manual that covers each specific item requiring Special Inspections that is indicated on the Schedule of Special Inspections. Provide names and qualifications of each special inspector who will be performing the Special Inspections for each specific item. Provide detail on how the Special Inspections are to be carried out for each item so that the expectations are clear for the General Contractor and the Subcontractor performing the work.

Make a copy of the Special Inspections Project Manual available on the job site during construction. Submit a copy of the Special Inspections Project Manual for approval.

h. Attend coordination and mutual understanding meeting where the information in the Special Inspections Project Manual will be reviewed to verify that all parties have a clear understanding of the Special Inspections provisions and the individual duties and responsibilities of each party.

i. Maintain a 3- ring binder for the Special Inspector's daily and biweekly reports and the Special Inspections Project Manual. This file must be located in a conspicuous place in the project trailer/office to allow review by the Contracting Officer and the DOR.

j. Submit a copy of the Special Inspector's daily reports to the QC Manager.

k. Discrepancies that are observed during Special Inspections must be reported to the QC Manager for correction. If discrepancies are not corrected before the special inspector leaves the site the observed discrepancies must be documented in the daily report.

l. Submit a biweekly Special Inspections report until all work requiring Special Inspections is complete. A report is required for each biweekly period in which Special Inspections activity occurs, and must include the following:

(1) A brief summary of the work performed during the reporting time frame.

(2) Changes and/or discrepancies with the drawings, specifications and mechanical or electrical component certification, that were observed during the reporting period.

(3) Discrepancies which were resolved or corrected.

(4) A list of nonconforming items requiring resolution.

(5) All applicable test results including nondestructive testing reports.

o. At the completion of the project submit a comprehensive final report of Special Inspections that documents the Special Inspections completed for the project and corrections of all discrepancies noted in the daily reports. The comprehensive final report of Special Inspections must be signed, dated and bear the seal of the SIOR.

3.1.2 Quality Control Manager

a. Maintain a rework items list that includes discrepancies noted on the Special Inspectors daily report.

3.1.3 Special Inspectors

a. Inspect all elements of the project for which the special inspector is qualified to inspect and are identified in the Schedule of Special Inspections.

b. Attend preparatory phase meetings related to the Definable Feature of Work (DFOW) for which the special inspector is qualified to inspect.

c. Submit a copy of the daily reports to the QC Manager.

d. Discrepancies that are observed during Special Inspections must be reported to the QC Manager for correction. If discrepancies are not corrected before the special inspector leaves the site the observed discrepancies must be documented in the daily report.

e. Submit a biweekly Special Inspection Report until all inspections are complete. A report is required for each biweekly period in which Special Inspections activity occurs, and must include the following:

(1) A brief summary of the work performed during the reporting time frame.

(2) Changes and/or discrepancies with the drawings, specifications and mechanical or electrical component certification, that were observed during the reporting period.

(3) Discrepancies which were resolved or corrected.

(4) A list of nonconforming items requiring resolution.

5) All applicable test result including nondestructive testing reports.

f. At the completion of the project submit a comprehensive final report of Special Inspections that documents the Special Inspections completed for the project and corrections of all discrepancies noted in the daily reports. The comprehensive final report of Special Inspections must be signed, dated and indicate the certification of the special inspector qualifying them to conduct the inspection.

k. Submit daily reports to the SIOR.

3.2 DEFECTIVE WORK

Check work as it progresses, but failure to detect any defective work or materials must in no way prevent later rejection if defective work or materials are discovered, nor obligate the Contracting Officer to accept such work.

-- End of Section --

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TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C511	(2017; R 2021) Reduced-Pressure Principle Backflow Prevention Assembly

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 241	(2022) Standard for Safeguarding Construction, Alteration, and Demolition Operations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2009; Rev 2012) Manual on Uniform Traffic Control Devices

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Construction Site Plan; G, RO

Traffic Control Plan; G, RO

Haul Road Plan; G, RO

Contractor Computer Cybersecurity Compliance Statements; G, RO

Contractor Temporary Network Cybersecurity Compliance Statements; G, RO

SD-06 Test Reports

Backflow Preventer Tests

SD-07 Certificates

Backflow Tester Certification

Backflow Preventers Certificate of Full Approval

1.3 CONSTRUCTION SITE PLAN

Prior to the start of work, submit for Government approval a site plan showing the locations and dimensions of temporary facilities (including layouts and details, equipment and material storage area (onsite and offsite), and access and haul routes, avenues of ingress/egress to the fenced area and details of the fence installation. Identify any areas which may have to be graveled to prevent the tracking of mud. Indicate if the use of a supplemental or other staging area is desired. Show locations of safety and construction fences, site trailers, construction entrances, trash dumpsters, temporary sanitary facilities, and worker parking areas.

1.4 BACKFLOW PREVENTERS CERTIFICATE

1.4.1 Backflow Tester Certificate

Prior to testing, submit to the Contracting Officer certification issued by the State or local regulatory agency attesting that the backflow tester has successfully completed a certification course sponsored by the regulatory agency. Tester must not be affiliated with a company participating in other phases of this Contract.

1.4.2 Backflow Prevention Training Certificate

Submit a certificate recognized by the State or local authority that states the Contractor has completed at least 10 hours of training in backflow preventer installations. The certificate must be current.

1.5 DOD CONDITION OF READINESS (COR)

DOD will set the Condition of Readiness (COR) based on the weather forecast for sustained winds 50 knots (58 mph) or greater. Contact the Contracting Officer for the current COR setting.

Monitor weather conditions a minimum of twice a day and take appropriate actions according to the approved Emergency Plan in the accepted Accident Prevention Plan, EM 385-1-1 Section 01 Emergency Planning and the instructions below.

Unless otherwise directed by the Contracting Officer, comply with:

a. Condition FOUR (Sustained winds of 58 mph or greater expected within 72 hours): Normal daily jobsite cleanup and good housekeeping practices. Collect and store in piles or containers scrap lumber, waste material, and rubbish for removal and disposal at the close of each work day. Maintain the construction site including storage areas, free of accumulation of debris. Stack form lumber in neat piles less than 3.3 feet high. Remove all debris, trash, or objects

that could become missile hazards. Review requirements pertaining to "Condition THREE" and continue action as necessary to attain "Condition FOUR" readiness. Contact Contracting Officer for weather and COR updates and completion of required actions.

b. Condition THREE (Sustained winds of 58 mph or greater expected within 48 hours): Maintain "Condition FOUR" requirements and commence securing operations necessary for "Condition ONE" which cannot be completed within 18 hours. Cease all routine activities which might interfere with securing operations. Commence securing and stow all gear and portable equipment. Make preparations for securing buildings. Reinforce or remove formwork and scaffolding. Secure machinery, tools, equipment, materials, or remove from the jobsite. Expend every effort to clear all missile hazards and loose equipment from general base areas. Contact Contracting Officer for weather and COR updates and completion of required actions. Review requirements pertaining to "Condition TWO" and continue action as necessary to attain "Condition THREE" readiness.

c. Condition TWO (Sustained winds of 58 mph or greater expected within 24 hours): Secure the jobsite, and leave Government premises.

d. Condition ONE. (Sustained winds of 58 mph or greater expected within 12 hours): Contractor access to the jobsite and Government premises is prohibited.

1.6 CYBERSECURITY DURING CONSTRUCTION

{For Reference Only: This subpart (and its subparts) relates to AC-18, SA-3, CCI-00258.} Meet the following requirements throughout the construction process.

1.6.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. When used, contractor computers must meet the following requirements:

1.6.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.6.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. All computers used on this project must be scanned using the installed software at least once per day.

1.6.1.3 Passwords and Passphrases

The passwords and passphrases for all computers must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.6.1.4 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-50-0 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.6.2 Temporary IP Networks

Provide Government access to Contractor furnished temporary IP networks during construction. When used, temporary contractor-installed IP networks must meet the following requirements:

1.6.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than IP networks provided under this project or Government furnished IP networks provided for this purpose. Any and all network access from outside the project site is prohibited.

1.6.3 Government Access to Network

Government personnel, as defined, prescribed, and identified by the Contracting Officer, must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification. If there is a Government agency responsible for network access, identify that agency.

1.6.4 Temporary Wireless IP Networks

1.6.4.1 Contractor Provided Wi-Fi Network

Provide standalone Wi-Fi network for authorized Government personnel. Network access must be available throughout the jobsite and for the entire Contract period. The Government will use the Wi-Fi service for coordination in the field and related activities. Do not attach or connect the temporary Wi-Fi network to Government networks or systems unrelated to construction activities.

Password information must adhere to requirements outlined in Paragraph PASSWORDS AND PASSPHRASES. Provide password and Wi-Fi network name (SSID) to the Contracting Officer for Government personnel access. Wi-Fi performance must be capable of handling bandwidth to support Government and Contractor activities, including drawing and model access onsite. Provide a point of contact for reporting Wi-Fi outages.

1.6.4.2 Temporary Wireless IP Networks Security

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks must not interfere with existing wireless network and must use WPA2 security. Network names (SSID) for wireless networks must be changed from their default values.

1.6.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.6.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-50-0 Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

PART 2 PRODUCTS

2.1 TEMPORARY SIGNAGE

2.1.1 Bulletin Board

Prior to the commencement of work activities, provide a clear weatherproof covered bulletin board not less than 36 by 48 inches in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the Contract, Wage Rate Information poster, Safety and Health Information as required by EM 385-1-1 Section 01 and other information approved by the Contracting Officer. Coordinate requirements herein with 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS. Locate the bulletin board at the project site in a conspicuous place easily accessible to all employees, and in location as approved by the Contracting Officer.

2.1.2 Warning Signs

Post temporary signs, tags, and labels to give workers and the public adequate warning and caution of construction hazards according to the EM 385-1-1 Section 04. Attach signs to the perimeter fencing every 150 feet warning the public of the presence of construction hazards. Signs must require unauthorized persons to keep out of the construction site. Correct the data required by safety signs daily. Post signs at all points of entry designating the construction site as a hard hat area.

2.2 TEMPORARY TRAFFIC CONTROL

2.2.1 Haul Roads

Construct access and haul roads necessary for proper prosecution of the work under this Contract in accordance with EM 385-1-1 Section 04. Construct with suitable grades and widths; avoid sharp curves, blind corners, and dangerous cross traffic. Submit haul road plan for approval. Provide necessary lighting, signs, barricades, and distinctive markings for the safe movement of traffic. The method of dust control, although optional, must be adequate to ensure safe operation at all times. Location, grade, width, and alignment of construction and haul roads are subject to approval by the Contracting Officer. Lighting must be adequate to assure full and clear visibility for full width of haul

road and work areas during any night work operations.

2.2.2 Barricades

Erect and maintain temporary barricades to limit public access to hazardous areas. Barricades are required whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic. Securely place barricades clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

2.3 TEMPORARY WIRING

Provide temporary wiring in accordance with EM 385-1-1 Section 11, NFPA 241 and NFPA 70. Include monthly inspection and testing of all equipment and apparatus.

2.4 BACKFLOW PREVENTERS

Certificate of Full Approval from FCCCHR List, University of Southern California, attesting that the design, size and make of each backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. Certificate of Provisional Approval is not acceptable.

Reduced pressure principle type conforming to the applicable requirements AWWA C511.

PART 3 EXECUTION

3.1 EMPLOYEE PARKING

Construction Contract employees must park privately owned vehicles in an area designated by the Contracting Officer. Employee parking must not interfere with existing and established parking requirements of the Government installation.

3.2 AVAILABILITY AND USE OF UTILITY SERVICES

3.2.1 Temporary Utilities

Provide temporary utilities required for construction. Materials may be new or used, must be adequate for the required usage, not create unsafe conditions, and not violate applicable codes and standards.

See Section 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS, paragraph AVAILABILITY OF UTILITY SERVICES.

3.2.2 Sanitation

Provide and maintain within the construction area minimum field-type sanitary facilities in accordance with EM 385-1-1 Section 02. Locate the facilities behind the construction fence or out of the public view. Clean units and empty wastes at least once a week or more frequently into a municipal, district, or station sanitary sewage system, or remove waste to a commercial facility. Obtain approval from the system owner prior to discharge into a municipal, district, or commercial sanitary sewer system. Penalties or fines associated with improper discharge will be the

responsibility of the Contractor. Coordinate with the Contracting Officer and follow station regulations and procedures when discharging into the station sanitary sewer system. Maintain these conveniences at all times. Include provisions for pest control and elimination of odors. Government toilet facilities will not be available to Contractor's personnel.

3.2.3 Telephone

Make arrangements and pay all costs for telephone facilities desired.

3.2.4 Fire Protection

Provide temporary fire protection equipment for the protection of personnel and property during construction. Remove debris and flammable materials weekly to minimize potential hazards.

3.3 TRAFFIC PROVISIONS

3.3.1 Maintenance of Traffic

a. Conduct operations in a manner that will not close a thoroughfare or interfere with traffic on railways or highways except with written permission of the Contracting Officer at least 15 calendar days prior to the proposed modification date, and provide a Traffic Control Plan for Government approval detailing the proposed controls to traffic movement for approval. The plan must be in accordance with State and local regulations and the MUTCD, Part VI. Make all notifications and obtain all permits required for modification to traffic movements outside Station's jurisdiction.. Contractor may move oversized and slow-moving vehicles to the worksite provided requirements of the highway authority have been met.

b. Conduct work so as to minimize obstruction of traffic, and maintain traffic on at least half of the roadway width at all times. Obtain approval from the Contracting Officer prior to starting any activity that will obstruct traffic.

c. Provide, erect, and maintain, at Contractor's expense, lights, barriers, signals, passageways, detours, and other items, that may be required by the Life Safety Signage, overhead protection authority having jurisdiction.

d. Provide cones, signs, barricades, lights, or other traffic control devices and personnel required to control traffic. Do not use foil-backed material for temporary pavement marking because of its potential to conduct electricity during accidents involving downed power lines.

3.3.2 Protection of Traffic

Maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Contracting Officer. Measures for the protection and diversion of traffic, including the provision of watchmen and flagmen, erection of barricades, placing of lights around and in front of equipment the work, and the erection and maintenance of adequate warning, danger, and direction signs, will be as required by the State and local authorities having jurisdiction. Provide self-illuminated (lighted) barricades during hours of darkness. Brightly-colored (orange) vests are required for all personnel working in

roadways. Protect the traveling public from damage to person and property. Minimize the interference with public traffic on roads selected for hauling material to and from the site. Investigate the adequacy of existing roads and their allowable load limit. Contractor is responsible for the repair of damage to roads caused by construction operations.

3.3.3 Dust Control

Dust control methods and procedures must be approved by the Contracting Officer. Coordinate dust control methods with 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

3.4 REDUCED PRESSURE BACKFLOW PREVENTERS

Provide an approved reduced pressure backflow prevention assembly at each location where the Contractor taps into the Government potable water supply.

Perform backflow preventer tests using test equipment, procedures, and certification forms conforming to those outlined in the latest edition of the Manual of Cross-Connection Control published by the FCCCHR Manual. Test and tag each reduced pressure backflow preventer upon initial installation (prior to continued water use) and quarterly thereafter. Tag must contain the following information: make, model, serial number, dates of tests, results, maintenance performed, and signature of tester. Record test results on certification forms conforming to requirements cited earlier in this paragraph.

3.5 CONTRACTOR'S TEMPORARY FACILITIES

Contractor is responsible for security of their property. Provide adequate outside security lighting at the temporary facilities. Trailers must be anchored to resist high winds and meet applicable state or local standards for anchoring mobile trailers. Coordinate anchoring with EM 385-1-1 Section 04. The Contract Clause entitled "FAR 52.236-10, Operations and Storage Areas" and the following apply:

3.5.1 Storage Area

Construct a temporary 6 foot high chain link fence around trailers and materials. Include plastic strip inserts, so that visibility through the fence is obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit. Do not place or store trailers, materials, or equipment outside the fenced area unless such trailers, materials, or equipment are assigned a separate and distinct storage area by the Contracting Officer away from the vicinity of the construction site but within the installation boundaries. Trailers, equipment, or materials must not be open to public view with the exception of those items which are in support of ongoing work on the current day. Do not stockpile materials outside the fence in preparation for the next day's work. Park mobile equipment, such as tractors, wheeled lifting equipment, cranes, trucks, and like equipment within the fenced area at the end of each work day.

Keep fencing in a state of good repair and proper alignment. If the Contractor elects to traverse grassed or unpaved areas which are not established roadways with construction equipment or other vehicles, cover the grassed or unpaved areas with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established

roadways; gravel gradation must be at the Contractor's discretion. Mow and maintain grass located within the boundaries of the construction site for the duration of the project. Grass and vegetation along fences, structures, under trailers, and in areas not accessible to mowers must be edged or trimmed neatly.

3.5.2 Supplemental Storage Area

Upon request, and pending availability, the Contracting Officer will designate another or supplemental area for the use and storage of trailers, equipment, and materials. This area may not be in close proximity of the construction site but will be within the installation boundaries. Maintain the area in a clean and orderly fashion and secured if needed to protect supplies and equipment. Utilities will not be provided to this area by the Government.

3.5.3 Appearance of Trailers

a. Trailers must be roadworthy and comply with all appropriate state and local vehicle requirements. Trailers which are rusted, have peeling paint or are otherwise in need of repair will not be allowed on Installation property. Trailers must present a clean and neat exterior appearance and be in a state of good repair.

b. Maintain the temporary facilities. Failure to do so will be sufficient reason to require their removal at the Contractor's expense.

3.5.4 Safety Systems

Protect the integrity of all installed safety systems or personnel safety devices. Obtain prior approval from the Contracting Officer if entrance into systems serving safety devices is required. If it is temporarily necessary to remove or disable personnel safety devices in order to accomplish Contract requirements, provide alternative means of protection prior to removing or disabling any permanently installed safety devices or equipment and obtain approval from the Contracting Officer.

3.5.5 Weather Protection of Temporary Facilities and Stored Materials

Take necessary precautions to ensure that roof openings and other critical openings in the building are monitored carefully. Take immediate actions required to seal off such openings when rain or other detrimental weather is imminent, and at the end of each workday. Ensure that the openings are completely sealed off to protect materials and equipment in the building from damage.

3.5.5.1 Building and Site Storm Protection

When a warning of gale force winds is issued, take precautions to minimize danger to persons, and protect the work and nearby Government property. Precautions must include, but are not limited to, closing openings; removing loose materials, tools and equipment from exposed locations; and removing or securing scaffolding and other temporary work. Close openings in the work when storms of lesser intensity pose a threat to the work or any nearby Government property.

3.6 GOVERNMENT FIELD OFFICE

3.6.1 Accomodations for Government Inspectors

Provide approximately 1,440 square feet of floor area (two - 12 ft x 60 ft trailers), co-located where directed on the project site, within 45 days of NTP for the remaining duration of the construction contract. Lease all buildings, rent all equipment and furniture, connect all utilities to SBIRS/BSFB systems, and make all utility payments. Provide space heat, air conditioning, electric light and power, potable hot/cold water, sewer service, and restrooms. For the duration of the contract, enforce all Storm Water Pollution Prevention (SWPPP) requirements. At the completion of the project or at the direction of the COR, coordinate and pay for the removal of the trailers and furniture, disconnect all utilities and restore the immediate trailer site. Connect and disconnect utilities in accordance with local codes and to the satisfaction of the Contracting Officer.

Securely anchor each trailer to the ground at all four corners to guard against movement during high winds. Coordinate requirements for proper anchoring with EM 385-1-1.

3.7 PLANT COMMUNICATIONS

Whenever the individual elements of the plant are located so that operation by normal voice between these elements is not satisfactory, install a satisfactory means of communication, such as telephone or other suitable devices and make available for use by Government personnel.

3.8 TEMPORARY PROJECT SAFETY FENCING

As soon as practicable, but not later than 15 days after the date established for commencement of work, furnish and erect temporary project safety fencing at the work site. Maintain the safety fencing during the life of the Contract and, upon completion and acceptance of the work, remove from the work site.

3.9 CLEANUP

Remove construction debris, waste materials, packaging material and the like from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways must be cleaned away. Store all salvageable materials resulting from demolition activities within the fenced area described above or at the supplemental storage area. Neatly stack stored materials not in trailers, whether new or salvaged.

3.10 RESTORATION OF STORAGE AREA

Upon completion of the project remove the bulletin board, signs, barricades, haul roads, and all other temporary products from the site. After removal of trailers, materials, and equipment from within the fenced area, remove the fence. Restore areas used during the performance of the Contract to the original or better condition. Remove gravel used to traverse grassed areas and restore the area to its original condition, including top soil and seeding as necessary.

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ENVIRONMENTAL PROTECTION
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/AWWA C651-99	Standard for Disinfecting Water Mains

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements
WETLAND MANUAL	Corps of Engineers Wetlands Delineation Manual Technical Report Y-87-1

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

33 CFR 328	Definitions of Waters of the United States
40 CFR 82	Protection of Stratospheric Ozone
40 CFR 112	Oil Pollution Prevention
40 CFR 152 - 186	Pesticide Programs
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 279	Standards for the Management of Used Oil
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 355	Emergency Planning and Notification
40 CFR 68	Chemical Accident Prevention Provisions
49 CFR 171 - 178	Hazardous Materials Regulations

1.2 DEFINITIONS

1.2.1 Class I and II Ozone Depleting Substance (ODS)

Class I ODS is defined in Section 602(a) of The Clean Air Act. A list of Class I ODS can be found on the EPA website at the following weblink. https://www.epa.gov/ozone-layer-protection/ozone-depleting-substances.

Class II ODS is defined in Section 602(s) of The Clean Air Act. A list of Class II ODS can be found on the EPA website at the following weblink. https://www.epa.gov/ozone-layer-protection/ozone-depleting-substances.

1.2.2 Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally and/or historically.

1.2.3 Environmental Protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2.4 Contractor Generated Hazardous Waste

Contractor generated hazardous waste means materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste streams would typically consist of material brought on site by the Contractor to execute work, but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e. methyl ethyl ketone, toluene etc.), waste thinners,excess paints, excess solvents, waste solvents, and excess pesticides, and contaminated pesticide equipment rinse water.

1.2.5 Installation Pest Management Coordinator

Installation Pest Management Coordinator (IPMC) is the individual officially designated by the Installation Commander to oversee the Installation Pest Management Program and the Installation Pest Management Plan.

1.2.6 Land Application for Discharge Water

The term "Land Application" for discharge water implies that the Contractor shall discharge water at a rate which allows the water to percolate into the soil. No sheeting action, soil erosion, discharge into storm sewers, discharge into defined drainage areas, or discharge into the "waters of the United States" shall occur. Land Application shall be in compliance with all applicable Federal, State, and local laws and regulations.

1.2.7 Pesticide

Pesticide is defined as any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, or intended for use as a plant regulator, defoliant or desiccant.

1.2.8 Pests

The term "pests" means arthropods, birds, rodents, nematodes, fungi, bacteria, viruses, algae, snails, marine borers, snakes, weeds and other organisms (except for human or animal disease-causing organisms) that adversely affect readiness, military operations, or the well-being of personnel and animals; attack or damage real property, supplies, equipment, or vegetation; or are otherwise undesirable.

1.2.9 Surface Discharge

The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers,creeks, and/or "waters of the United States" and would require a permit to discharge water from the governing agency.

1.2.10 Waters of the United States

All waters which are under the jurisdiction of the Clean Water Act, as defined in 33 CFR 328.

1.2.11 Wetlands

Wetlands means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, and bogs. Official determination of whether or not an area is classified as a wetland must be done in accordance with WETLAND MANUAL.

1.2.12 Oily Waste

Oily waste are those materials that are, or were, mixed with Petroleum, Oils, and Lubricants (POLs) and have become separated from that POLs. Oily wastes also means materials, including wastewaters, centrifuge solids, filter residues or sludges, bottom sediments, tank bottoms, and sorbents which have come into contact with and have been contaminated by, POLs and may be appropriately tested and discarded in a manner which is in compliance with other state and local requirements.

This definition includes materials such as oily rags, "kitty litter" sorbent clay and organic sorbent material. These materials may be land filled provided that: It is not prohibited in other state regulations or local ordinances; the amount generated is "de minimus" (a small amount); it is the result of minor leaks or spills resulting from normal process operations; and free-flowing oil has been removed to the practicable extent possible. Large quantities of this material, generated as a result of a major spill or in lieu of proper maintenance of the processing equipment, are a solid waste. As a solid waste, perform a hazardous waste determination prior to disposal. As this can be an expensive process, it is recommended that this type of waste be minimized through good

housekeeping practices and employee education.

1.3 GENERAL REQUIREMENTS

The Contractor shall minimize environmental pollution and damage that may occur as the result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of this contract. The Contractor shall comply with all applicable environmental Federal, State, and local laws and regulations. The Contractor shall be responsible for any delays resulting from failure to comply with environmental laws and regulations.

1.4 SUBCONTRACTORS

The Contractor shall ensure compliance with this section by subcontractors.

1.5 PAYMENT

No separate payment will be made for work covered under this section. The Contractor shall be responsible for payment of fees associated with environmental permits, application, and/or notices obtained by the Contractor. All costs associated with this section shall be included in the contract price. The Contractor shall be responsible for payment of all fines/fees for violation or non-compliance with Federal, State, Regional and local laws and regulations.

1.6 SUBMITTALS

The following administrative submittals shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Environmental Protection Plan; G, RO

Demolition Notification Application Form

Spill Prevention Control and Countermeasure (SPCC) Plan; G, RO

SD-07 Certificates

Monthly Hazardous Material Tracking Report

1.7 ENVIRONMENTAL COORDINATION, PERMITS, NOTICES, REVIEWS AND/OR APPROVALS

Contact the appropriate Federal, State, Regional, and local environmental agencies to identify all required environmental permits (construction and operating), notices, reviews, and approvals required for the project. Once the requirements are identified, coordinate the requirements with the Environmental Flight and the Contracting Officer in regard to implementation for a Federal Facility project. In addition, provide the Environmental Flight of Buckley SFB a copy of any permit applications prior to submission to the regulating agency, and a copy of the final permit, once obtained. Ensure that all coordination, permits, notices, reviews and/or approvals are completed with each applicable phase of the

design prior to construction starting for that phase. The Government is not responsible for contract delays resulting from failure to obtain environmental permits, notices, reviews and/or approvals when required.

For any project support activities involving earth disturbance that occur off Buckley SFB property or partially off Buckley property, obtain any environmental permits including but not limited to stormwater, floodplain and wetland permits that are issued by the federal, state and local jurisdictions having authority. Maintain compliance with applicable permit(s), associated permit activity and the costs associated with aforementioned permits and activities.

1.7.1 Applications, Supporting Documents, and Fees

Obtain and complete all environmental permit applications and notices including any documents required for a modification for an existing permit held by the Facility. Prepare all supporting documents, including but not limited to engineering reports, emission surveys, diagrams, pollutant load calculations, etc. If, in lieu of permits, the governing agency requires review and approval of the design, submit and obtain approval of the design and associated documents. Pay all fees associated with the permits and make all required applications, reviews, approvals, and notices.

1.7.2 Buckley SFB's Environmental Permits, Notices, Reviews, and/or Approvals

The following is a listing of permits, notices, reviews, and/or approvals which **may be** required for this project. This listing and requirements are not to be considered all-inclusive by the Contractor, but is provided as information to be used in successfully accomplishing the environmental compliances.

a. In the State of Colorado, **EPA** has authority for the National Pollutant Discharge Elimination System (NPDES) on **Federal Facilities**. Construction activities which result in the disturbance of 1 acre of land or more, require coverage under the EPA Storm Water General Permit For Construction Activities (Colorado Permit No. COR40000). The Contractor shall be the permittee. The Contractor shall be responsible for editing and applying Specification Section 01 41 26.05 24 (FEDERAL FACILITIES COLORADO) NPDES PERMIT REQUIREMENTS FOR STORM WATER DISCHARGES FROM CONSTRUCTION SITES.

b. Municipal Separate Storm Sewer Systems (MS4) Permit. Buckley Space Force Base is under a Municipal Separate Storm Sewer System (MS4) permit, issued by the US Environmental Protection Agency (EPA), which allows discharges of stormwater from Buckley SFB. The MS4 permit also requires Buckley SFB to manage a stormwater program and enforce compliance with EPA-issued permits. Unauthorized discharges to stormwater conveyances are prohibited under the legal authorities of the Buckley Municipal Separate Storm Sewer System (MS4) permit. Non-stormwater discharges into the storm sewer system warrants enforcement procedures and actions.

c. A State of Colorado Air Pollution Emission Notice (APEN) for Fugitive Dust Permit for Land Development is required, if construction disturbs surface areas of more than 25 contiguous acres **or** if surface areas of more than 1 acre are to remain disturbed more than six months. The Colorado Department of

Public Health and Environment (CDPHE), Division Air Quality issues the permit. The Contractor shall be the permittee and the permit is required prior to any construction starting on the project site. The submittal package to CDPHE shall include a completed Air Pollution Emission Notice (APEN), a Land Disturbance Dust Control Plan, the grading plan, the location plan, and the application fee. The CDPHE requires a minimum of 30 days for review of the package. Prior to issuing the Construction Permit, CDPHE requires the permittee to pay the cost of the review in addition to the application fee.

d. A State of Colorado (CDPHE) Air Pollution Control Division APEN permit for Application for Construction Permit. Buckley Space Force Base has a Title V air permit for the base. Any new generators with diesel reciprocating interal combusion engines will need to be approved by the State. The Contractor is required to pay any fees associated with this permit. Also, if this project has any new air emissions source, such as new generator, the Contractor will be required to furnish the Buckley Space Force Base Environmental Flight Office a copy of all required air emissions information to be added to their current air permit.

e. Coordination and notification may be required prior to discharge of hydrostatic test water and disinfection water to the sanitary sewer and/or to the surface for land application. The Contractor shall be responsible for coordination with the Environmental Flight, 460 CES/CEV, and the Contracting Officer prior to discharge. The discharge shall be in accordance with all Federal, State, and local laws and regulations.

f. If this project will use materials containing hazardous materials. Safety Data Sheets for all chemicals must be available on site at all times. Only ESOH-MIS (formally EMIS) approved chemicals are allowed on Buckley SFB. No hazardous chemicals are allowed to be left on Buckley SFB without prior written approval from the contracting officer or his representative.

g. All work performed on domestic water mains must comply with ANSI/AWWA C651-99 (most current revision). All water main flushing, superchlorination, bacteriological testing and other activities involving the water mains must be coordinated through Bioenvironmental Engineering. Contact the main number at (720) 847-6351.

h. Complete the Installation Fill Dirt Application for all topsoil and backfill used on the project. Applications are available through the Toxics Program Manager, Matthew Christensen, (720) 847-5723, matthew.christensen.11@spaceforce.mil or alternate, Matthew Rodgers, (720) 847-7245, matthew.rodgers.7@spaceforce.mil. Complete applications prior to backfill.

i. Submit application and pay all associated fees to obtain an UST installation permit from the State of Colorado Division of Oil and Public Safety (OPS) prior to construction. Submit registration for the UST system to 460 CES/CEIE for Base Civil Engineer's review and signature before contractor may submit to OPS and pay all fees associated with registration and inspection." Provide installation dates, scheduled regulatory inspections, and fill dates with 460 CES/CEIE Tank Program to ensure tanks are added to spill

prevention control countermeasure (SPCC) plan inventory and Dept. of Air Force Storage Tank Accounting and Reporting system."

j. Submit a Demolition Notification Application Form to the Colorado Department of Public Health & Environment (CDPHE) for each facility to be demolished, along with payment of a notification fee, a minimum of 10 days prior to demolition activities. Provide a copy of the approved demolition permit to the Contracting Officer and BSFB Toxics Program Manager, Matthew Christensen, (720) 847-5723, matthew.christensen.11@spaceforce.mil or alternate, Matthew Rodgers, (720) 847-7245, matthew.rodgers.7@spaceforce.mil. Demolition notification application information and form can be found under the forms heading at: https://www.colorado.gov/cdphe/asbestos

1.8 ENVIRONMENTAL PROTECTION PLAN

Prior to commencing construction activities or delivery of materials to the site, submit an Environmental Protection Plan for review and approval by the Contracting Officer. The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental issues which the Contractor must address during construction. Issues of concern shall be defined within the Environmental Protection Plan as outlined in this section. The Contractor shall address each topic at a level of detail commensurate with the environmental issue and required construction task(s). Topics or issues which are not identified in this section, but which the Contractor considers necessary, shall be identified and discussed after those items formally identified in this section. Prior to submittal of the Environmental Protection Plan, the Contractor shall meet with the Contracting Officer for the purpose of discussing the implementation of the initial Environmental Protection Plan; possible subsequent additions and revisions to the plan including any reporting requirements; and methods for administration of the Contractor's Environmental Plans. The Environmental Protection Plan shall be current and maintained onsite by the Contractor.

1.8.1 Compliance

No requirement in this Section shall be construed as relieving the Contractor of any applicable Federal, State, and local environmental protection laws and regulations. During Construction, the Contractor shall be responsible for identifying, implementing, and submitting for approval any additional requirements to be included in the Environmental Protection Plan.

1.8.2 Contents

The environmental protection plan shall include, but shall not be limited to, the following:

a. Name(s) of person(s) within the Contractor's organization who is(are) responsible for ensuring adherence to the Environmental Protection Plan.

b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site, if applicable.

c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

d. Description of the Contractor's environmental protection personnel training program.

e. An erosion and sediment control plan which identifies the type and location of the erosion and sediment controls to be provided. The plan shall include monitoring and reporting requirements to assure that the control measures are in compliance with the erosion and sediment control plan, Federal, State, and local laws and regulations. A Storm Water Pollution Prevention Plan (SWPPP) may be substituted for this plan.

f. Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on the site.

g. Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plan shall include measures to minimize the amount of mud transported onto paved public roads by vehicles or runoff.

h. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas including methods for protection of features to be preserved within authorized work areas.

i. The Spill Prevention and Control Plan (SPCC). Include the procedures, instructions, and reports to be used in the event of an unforeseen spill of a substance regulated by 40 CFR 68, 40 CFR 302, 40 CFR 355, and/or regulated under State or Local laws and regulations. The SPCC supplements the requirements of EM 385-1-1 and the Facility's Haz Mat Plan. The Hazardous Material Emergency Response Plan may be reviewed at the Environmental Flight office. Include in this plan as a minimum:

1. The name of the individual who will report any spills or hazardous substance releases and who will follow up with complete documentation. If a reportable quantity is released to the environment, this individual will immediately notify the Contracting Officer; 460 CES/CEIE Tank Program Manager, Matt Cohen; matthew.cohen.4@spaceforce.mil; 720-847-4655 and 460 CES/CEO Customer Service; (720) 847-9913; 460ces.ceow@us.af.mil. 460 CES/CEIE will be solely responsible for reporting spills to city of Aurora, state of Colorado, Environmental Protection Agency (EPA) and all other local, state, federal partners and regulators. Include a list of the required reporting channels and telephone numbers.

2. The name and qualifications of the individual who will be responsible for implementing and supervising the containment and cleanup.

3. Training requirements for Contractor's personnel and methods of accomplishing the training.

4. A list of materials and equipment to be immediately available at the job site, tailored to cleanup work of the potential hazard(s) identified.

5. The names and locations of suppliers of containment materials and locations of additional fuel oil recovery, cleanup, restoration, and material-placement equipment available in case of an unforeseen spill emergency.

6. The methods and procedures to be used for expeditious contaminant cleanup.

j. A non-hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris. The plan shall include schedules for disposal. The Contractor shall identify any subcontractors responsible for the transportation and disposal of solid waste. Licenses or permits shall be submitted for solid waste disposal sites that are not a commercial operating facility. Evidence of the disposal facility's acceptance of the solid waste shall be attached to this plan during the construction. The Contractor shall attach a copy of each of the Non-hazardous Solid Waste Diversion Reports to the disposal plan. The report shall be submitted on the first working day after the first quarter that non-hazardous solid waste has been disposed and/or diverted and shall be for the previous quarter (e.g. the first working day of January, April, July, and October). The report shall indicate the total amount of waste generated and total amount of waste diverted in cubic yards or tons along with the percent that was diverted.

k. A recycling and solid waste minimization plan with a list of measures to reduce consumption of energy and natural resources. The plan shall detail the Contractor's actions to comply with and to participate in Federal, State, Regional, and local government sponsored recycling programs to reduce the volume of solid waste at the source.

l. An air pollution control plan detailing provisions to assure that dust, debris, materials, trash, etc., do not become air borne and travel off the project site.

m. A contaminant prevention plan that: identifies potentially hazardous substances to be used on the job site; identifies the intended actions to prevent introduction of such materials into the air, water, or ground; and details provisions for compliance with Federal, State, and local laws and regulations for storage and handling of these materials. In accordance with EM 385-1-1, a copy of the Safety Data Sheets (SDS) and the maximum quantity of each hazardous material to be on site at any given time shall be included in the contaminant prevention plan. As new hazardous materials are brought on site or removed from the site, the plan shall be updated. Copies of all correspondce, inventories, notifications, etc. to the appropriate Base's Hazaardous Material Office and the Contracting Officer shall be included in the plan.

n. A waste water management plan that identifies the methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water,

hydrostatic test water, and water used in flushing of lines. If a settling/retention pond is required, include the design of the pond including drawings, removal plan, and testing requirements for possible pollutants. If land application will be the method of disposal for the waste water, include a sketch showing the location for land application along with a description of the pretreatment methods to be implemented. If surface discharge will be the method of disposal, include a copy of the permit and associated documents as an attachment prior to discharging the waste water. If disposal is to a sanitary sewer, include documentation that the Waste Water Treatment Plant Operator has approved the flow rate, volume, and type of discharge. Do not discharge to the sanitary sewer wastewater which differs significantly in quantity or quality from discharges under normal conditions without permission from Metro Water Recovery (Metro), Buckley's wastewater regulator. To obtain permission to discharge to the sanitary sewer, provide analytical sampling showing that the discharge meets Metro regulatory limits. Allow a minimum of four weeks and contact Matthew Cohen, matthew.cohen.4@spaceforce.mil Water Quality PM to coordinate permission or to report an accidental discharge to the sanitary sewer.

o. A historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on the project site: and/or identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in the area are discovered during construction. The plan shall include methods to assure the protection of known or discovered resources and shall identify lines of communication between Contractor personnel and the Contracting Officer.

p. A pesticide treatment plan shall be included and updated, as information becomes available. The plan shall include: sequence of treatment, dates, times, locations, pesticide trade name, EPA registration numbers, authorized uses, chemical composition, formulation, original and applied concentration, application rates of active ingredient (i.e. pounds of active ingredient applied), equipment used for application and calibration of equipment. The Contractor is responsible for Federal, State, Regional and Local pest management record keeping and reporting requirements as well as any additional installation specific requirements.

1.8.3 Appendix

Copies of all environmental permits, permit application packages, approvals to construct, notifications, certifications, reports, and termination documents shall be attached,as an appendix, to the Environmental Protection Plan.

1.9 PROTECTION FEATURES

This paragraph supplements the Contract Clause PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS. Prior to start of any onsite construction activities, the Contractor, Contracting Officer, and Base Natural Resources Manager shall make a joint condition survey. Immediately following the survey, the Contractor shall prepare a brief report including a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically

identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the Contractor's assigned storage area and access route(s), as applicable. This survey report shall be signed by both the the Contractor and the Contracting Officer upon mutual agreement as to its accuracy and completeness. The Contractor shall protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference which their preservation may cause to the Contractor's work under the contract.

1.10 ENVIRONMENTAL ASSESSMENT OF CONTRACT DEVIATIONS

Any deviations, requested by the Contractor, from the drawings,plans and specifications which may have an environmental impact will be subject to approval by the Contracting Officer and may require an extended review, processing, and approval time. The Contracting Officer reserves the right to disapprove alternate methods, even if they are more cost effective, if the Contracting Officer determines that the proposed alternate method will have an adverse environmental impact.

1.11 NOTIFICATION

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with Federal, State or local environmental laws or regulations, permits, and other elements of the Contractor's Environmental Protection plan. The Contractor shall, after receipt of such notice, inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or equitable adjustments allowed to the Contractor for any such suspensions. This is in addition to any other actions the Contracting Officer may take under the contract, or in accordance with the Federal Acquisition Regulation or Federal Law.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 ENVIRONMENTAL PERMITS AND COMMITMENTS

The Contractor shall be responsible for obtaining and complying with all environmental permits and commitments required by Federal, State, Regional, and local environmental laws and regulations.

3.2 LAND RESOURCES

Confine all activities to areas defined by the drawings and specifications. Prior to the beginning of any construction, identify any land resources to be preserved within the work area. Except in areas indicated on the drawings or specified to be cleared, do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without approval. Do not fasten or attach any ropes, cables, or guys to any trees for anchorage unless specifically authorized. Provide effective protection for land and vegetation resources at all times as defined in the following subparagraphs. Remove stone, soil, or other materials displaced into uncleared areas. Limit equipment, staging, and storage to stabilized and/or paved surfaces to eliminate unnecessary disturbances of vegetated

areas.

3.2.1 Work Area Limits

Prior to commencing construction activities, the Contractor shall mark the areas that need not be disturbed under this contract. Isolated areas within the general work area which are not to be disturbed shall be marked or fenced. Monuments and markers shall be protected before construction operations commence. Where construction operations are to be conducted during darkness, any markers shall be visible in the dark. The Contractor's personnel shall be knowledgeable of the purpose for marking and/or protecting particular objects.

3.2.2 Landscape

Clearly identify trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved by marking, fencing, or wrapping with boards, or any other approved techniques. Restore landscape features damaged or destroyed during construction operations outside the limits of the approved work area. Development of specifications for relocation/replacing trees and landscaping, and submission of those specifications in conjunction with design submittals will be the responsibility of the D/B designer. Water all relocated trees and shrubs for no less than twelve months after relocation, unless an irrigation system is provided. Avoid all disturbances of vegetated areas as much as feasible. Revegetate any disturbed areas IAW the Buckley installation facility standards (IFS) and specified seed mixes. Replace all disturbed or removed landscaping and sod with a like kind, and in accordance with the Buckley IFS.

3.2.3 Erosion and Sediment Controls

Provide erosion and sediment control measures in accordance with Federal, State, and local laws and regulations. Erosion controls are required on all disturbed areas with a slope greater than 1% to prevent erosion/sediment transport prior to establishing vegetation. In addition, install erosion controls to prevent erosion with concentrated flows along ditch flow lines and outlet points. Select and maintain erosion and sediment controls such that construction activities do not result in sediment and other pollutants leaving the site, entering the stormwater sewer system, and violating the Base's MS4 permit. Unauthorized discharges to stormwater conveyances are prohibited under the legal authorities of the Buckley Municipal Separate Storm Sewer System (MS4) permit. Non-stormwater discharges into the storm sewer system warrants enforcement procedures and actions. Clean vehicle tracking on to impervious streets and roadways by the end of each working day. The area of bare soil exposed at any one time by construction operations should be kept to a minimum. Construct or install temporary and permanent erosion and sediment control best management practices (BMPs). BMPs may include, but not be limited to, vegetation cover, silt fences, stream bank stabilization, slope stabilization, silt fences, construction of terraces, interceptor channels, sediment traps, inlet and outfall protection, diversion channels, and sedimentation basins. Erosion controls selected shall be sufficient to prevent formation of rills and gullies from erosion and the transport of sediment. Install BMPs before any site work commences, and remove only after the site has been seeded, and stabilized in accordance with the Installation Facility Standards (IFS).

3.2.4 Contractor Facilities and Work Areas

The Contractor's field offices, staging areas, stockpile storage, and temporary buildings shall be placed in areas designated on the drawings or as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities shall be made only when approved. Erosion and sediment controls shall be provided for on-site borrow and spoil areas to prevent sediment from entering nearby waters. Temporary excavation and embankments for plant and/or work areas shall be controlled to protect adjacent areas.

3.3 WATER RESOURCES

The Contractor shall monitor construction activities to prevent pollution of surface and ground waters. Toxic or hazardous chemicals shall not be applied to soil or vegetation unless otherwise indicated. All water areas affected by construction activities shall be monitored by the Contractor. For construction activities immediately adjacent to impaired surface waters, the Contractor shall be capable of quantifying sediment or pollutant loading to that surface water when required by State or Federally issued Clean Water Act permits.

3.3.1 Dewatering Operations

Construction operations for dewatering shall be controlled at all times to maintain compliance with existing State water quality standards and designated uses of the surface water body. The Contractor shall comply with the State of Colorado water quality standards and anti-degradation provisions.

3.4 AIR RESOURCES

Equipment operation, activities, or processes performed by the Contractor shall be in accordance with all Federal, State, and Buckley air emission and performance laws and standards.

3.4.1 Preconstruction Air Permits

Notify the Air Program Manager, through the Contracting Officer, at least 6 months prior to bringing equipment, assembled or unassembled, onto the Installation, so that air permits can be secured. Necessary permitting time must be considered in regard to construction activities. Clean Air Act (CAA) permits must be obtained prior to bringing equipment, assembled or unassembled, onto the Installation.

Confirm that these permits have been obtained.

3.4.2 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials, such as from asphalt batch plants; shall be controlled at all times, including weekends, holidays and hours when work is not in progress. The Contractor shall maintain excavations, stockpiles, haul roads, permanent and temporary access roads, plant sites, spoil areas, borrow areas, and other work areas within or outside the project boundaries free from particulates which would cause the Federal, State, and local air pollution standards to be exceeded or which would cause a hazard or a nuisance. Best Management Practices shall be used to minimize fugitive dust. Opacity may not exceed

20% and measures shall be taken to prevent fugitive dust from migrating off-base. Sprinkling, chemical treatment of an approved type, baghouse, scrubbers, electrostatic precipitators or other methods will be permitted to control particulates in the work area. Sprinkling, to be efficient, must be repeated to keep the disturbed area damp at all times. The Contractor must have sufficient, competent equipment available to accomplish these tasks. Particulate control shall be performed as the work proceeds and whenever a particulate nuisance or hazard occurs. The Contractor shall comply with all State and local visibility regulations.

3.4.3 Odors

Odors from construction activities shall be controlled at all times. The odors shall not cause a health hazard and shall be in compliance with State regulations and/or local ordinances.

3.4.4 Sound Intrusions

The Contractor shall keep construction activities under surveillance and control to minimize environment damage by noise. The Contractor shall comply with the provisions of the State of Colorado rules.

3.4.5 Burning

Burning shall be prohibited on the Government premises.

3.5 CLASS I AND II ODS PROHIBITION

Class I and II ODS are Government property and must be returned to the Government for appropriate management. Coordinate with the Installation Environmental Office to determine the appropriate location for turn in of all reclaimed refrigerant.

3.6 VENTING OF REFRIGERANT

Accidental venting of a refrigerant is a release and must be reported immediately to the Contracting Officer. Intentional venting of refrigerants (including most Non-ODS substitute refrigerants) is prohibited per 40 CFR 82.

3.7 EPA CERTIFICATION REQUIREMENTS

Heating and air conditioning technicians must be certified through an EPA-approved program. Maintain copies of certifications at the employees' places of business; technicians must carry certification wallet cards, as provided by environmental law.

3.8 CHEMICAL MATERIALS MANAGEMENT AND WASTE DISPOSAL

Disposal of wastes shall be as directed below, unless otherwise specified in other sections and/or shown on the drawings.

3.8.1 Solid Wastes

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. Handling, storage, and disposal shall be conducted to prevent contamination. Segregation measures shall be employed so that no hazardous or toxic waste will become co-mingled with solid waste. The Contractor shall transport solid waste off

Government property and dispose of it in compliance with Federal, State, and local requirements for solid waste disposal. A Subtitle D RCRA permitted landfill shall be the minimum acceptable off-site solid waste disposal option. The Contractor shall verify that the selected transporters and disposal facilities have the necessary permits and licenses to operate. The Contractor shall comply with site procedures pertaining to the use of landfill areas. Coordination with the CEV prior to removing waste off Buckley SFB.

3.8.2 Chemicals and Chemical Wastes

Do not use lead or lead based paints, asbestos containing materials, or polychlorinated biphenyl products (PCB's) on this project. Provide a certification that none of the aforementioned materials were used on the project to the 460 CES/CEIE Toxics Manager, Mr. Matt Christensen, at 720-847-5723 or at matthew.christensen.11@spaceforce.mil

AFMAN32-7002 S.3.3.1 requires that all hazardous materials (HM) be submitted to 460 CES/CEIE for review and authorization prior to bringing on Buckley SFB. Provide manufacturer-specific part numbers and Safety Data Sheets (SDS) to 460 CES/CEIE along with container sizes to ensure correct usage tracking. Track all HM usage once approved for use and report to the Environmental Element each month. Submit Monthly Hazardous Material Tracking Report at the end of each month. Types of HM can include adhesives, paints, sealants, solvents, and similar products. Contact Tyler Walnoha 720-847-5296 for further information and assistance.

Dispense chemicals ensuring no spillage to the ground or water. Perform and document periodic inspections of dispensing areas to identify leakage and initiate corrective action. This documentation will be periodically reviewed by the Government. Collect chemical waste in corrosion resistant, compatible containers. Monitor collection drums and remove to a staging or storage area when contents are within 6 inches of the top. Classify, manage, store, and dispose of wastes in accordance with Federal, State, and local laws and regulations.

3.8.3 Contractor Generated Hazardous Wastes/Excess Hazardous Materials

Hazardous wastes are defined in 40 CFR 261, or are as defined by applicable State and local regulations. Hazardous materials are defined in 49 CFR 171 - 178. The Contractor shall, at a minimum, manage and store hazardous waste in compliance with 40 CFR 262 and shall manage and store hazardous waste in accordance with the Installation hazardous waste management plan. The Contractor shall take sufficient measures to prevent spillage of hazardous and toxic materials during dispensing. The Contractor shall segregate hazardous waste from other materials and wastes, shall protect it from the weather by placing it in a safe covered location, and shall take precautionary measures such as berming or other appropriate measures against accidental spillage. The Contractor shall be responsible for storage, describing, packaging, labeling, marking, and placarding of hazardous waste and hazardous material in accordance with 49 CFR 171 - 178, State, and local laws and regulations. The Contractor shall transport Contractor generated hazardous waste off Government property within 60 days in accordance with the Environmental Protection Agency and the Department of Transportation laws and regulations. The Contractor shall dispose of hazardous waste in compliance with Federal, State and local laws and regulations. Immediately report spills of hazardous or toxic materials to the Contracting Officer; 460 CES/CEIE Tank Program Manager, Matt Cohen; matthew.cohen.4@spaceforce.mil; 720-847-4655

and 460 CES/CEO Customer Service; (720) 847-9913; 460ces.ceow@us.af.mil. 460 CES/CEIE will be solely responsible for reporting spills to city of Aurora, state of Colorado, Environmental Protection Agency (EPA) and all other local, state, federal partners and regulators. Cleanup and cleanup costs due to spills shall be the Contractor's responsibility. The disposition of Contractor generated hazardous waste and excess hazardous materials are the Contractor's responsibility.

3.8.4 Fuel and Lubricants

Storage, fueling and lubrication of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spill and evaporation. Fuel, lubricants and oil shall be managed and stored in accordance with all Federal, State, Regional, and local laws and regulations. Used lubricants and used oil to be discarded shall be stored in marked corrosion-resistant containers and recycled or disposed in accordance with 40 CFR 279, State, and local laws and regulations. There shall be no storage of fuel on the project site. Fuel must be brought to the project site each day that work is performed.

3.8.5 Waste Water

Disposal of waste water shall be as specified below.

a. Waste water from construction activities, such as on site material processing, concrete curing, foundation and concrete clean-up, water used in concrete trucks, forms, etc. shall not be allowed to enter water ways or to be discharged prior to being treated to remove pollutants. The Contractor shall dispose of the construction related waste water off-Government property in accordance with all Federal, State, Regional and Local laws and regulations or by collecting and placing it in a retention pond where suspended material can be settled out and/or the water can evaporate to separate pollutants from the water. The site for the retention pond shall be coordinated and approved with the Contracting Officer. The residue left in the pond prior to completion of the project shall be removed, tested, and disposed off-Government property in accordance with Federal, State, and local laws and regulations. The area shall be backfilled to the original grade, top-soiled and seeded/sodded.

b. Water generated from dewatering activities shall be land applied on site in accordance with both the Federal and the State of Colorado laws and regulations for land application.

c. Water generated from the flushing of lines after disinfection or disinfection in conjunction with hydrostatic testing shall be land applied in accordance with all Federal, State, and local laws and regulations for land application or shall be discharged into the sanitary sewer with prior approval and/or notification to the Waste Water Treatment Plant's Operator. Please contact the 460 CES/CEIE Water Quality Program Manager (WQPM) Matthew Cohen (720)847-4655 at least 14 business days before any discharge to the sanitary sewer or quality from discharges under normal conditions and/or that may disrupt Wastewater System treatment processes or operations.

3.9 RECYCLING AND WASTE MINIMIZATION

The Contractor shall participate in State and local government sponsored recycling programs. The Contractor is further encouraged to minimize solid waste generation throughout the duration of the project.

3.10 NON-HAZARDOUS SOLID WASTE DIVERSION REPORT

The Contractor shall maintain an inventory of non-hazardous solid waste diversion and disposal of construction and demolition debris. The contractor shall divert from the landfill all eligible solid waste during construction and demolition activities. The Air Force goal for solid waste diversion is 60 percent. The goal for solid waste diversion for this project will also be 60 percent by weight. Diversion can be accomplished through recycling, waste to energy incineration, composting, mulching, reuse, and donation. The Contractor shall submit a report to the Contracting Officer on the first working day after each fiscal year quarter, starting the first quarter that non-hazardous solid waste has been generated. Please forward this report to Matthew Christensen at matthew.w.christensen11@us.af.mil. The following shall be included in the report:

a. Construction and Demolition (C&D) Debris Disposed = in cubic yards or tons, as appropriate.

b. Construction and Demolition (C&D) Debris Recycled = in cubic yards or tons, as appropriate.

c. Total C&D Debris Generated = in cubic yards or tons, as appropriate.

d. Waste Sent to Waste-To-Energy Incineration Plant (This amount should not be included in the recycled amount) = in cubic yards or tons, as appropriate.

e. Construction and Demolition debris (C&D) composted in cubic yards or tons, as appropriate.

f. Construction and Demolition debris (C&D) mulched in cubic yards or tons, as appropriate.

g. Construction and Demolition debris (C&D) reused in cubic yards or tons, as appropriate.

h. Construction and Demolition debris (C&D) donated in cubic yards or tons, as appropriate.

3.11 HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

If during excavation or other construction activities any previously unidentified or unanticipated historical, archaeological, and cultural resources are discovered or found, temporarily suspend all activities that may damage or alter such resources. Resources covered by this paragraph include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rock or coral alignments, pavings, wall, or other constructed features; and any indication of agricultural or other human historical activities. Upon such discovery or find, immediately notify the Contracting Officer and Cultural Resource Manager so that the appropriate authorities may be notified and a

determination made as to their significance and what, if any, special disposition of the finds should be made. Cease all activities that may result in impact to or the destruction of these resources. Secure the area and prevent employees or other persons from trespassing on, removing, or otherwise disturbing such resources. The Buckley SFB Cultural Resource Manager is: Matthew Hulbert, 460 CES/CEIE at 720-847-9059 or matthew.hulbert.1@spaceforce.mil

3.12 BIOLOGICAL RESOURCES

Minimize interference with, disturbance to, and damage to fish, wildlife, and plants including their habitat. Protect threatened and endangered animal and plant species including their habitat in accordance with Federal, State, Regional, and local laws and regulations. Identify and avoid disturbing the following species and/or their habitat. Do not assume that the list is all inclusive. These species have been identified on the Facility but are not at the present time on the project site. Ensure all contractor employees are able to identify and avoid disturbing the species and their habitat. Coordinate with the Facility Environmental Flight/Natural Resource Manager and the Contracting Officer if Threatened and/orEndangered Species are found on the project site. If wildlife is encountered (birds, bats, coyotes, deer, etc) and it won't leave the project area, contact the Buckley Natural Resource Manager. A nesting bird survey will need to be completed prior to any clearing and grubbing or tree removal at least 7 days prior to any ground disturbance. Reference the Buckley SFB Integrated Natural Resource Management Plan for more information on Threatened/Endangered species. Contact for the bird survey is the Natural Resource Manager: Matthew Hulbert, 460 CES/CEIE at 720-847-9059 or matthew.hulbert.1@spaceforce.mil

3.12.1 Burrowing Owl (Athene cunicularia)

The Burrowing Owl (Athene cunicularia) is a State of Colorado Threatened Species. Burrowing Owls uses prairie dog burrows as a nesting habitat. The burrowing owl may be found on the Facility, especially during the summer months. Unlike the prairie dogs the burrowing owls cannot be relocated and must not be disturbed during nesting (late March through July). Owls start to arrive in late February and remain until the end of October. If construction is starting during this period, a survey must be completed prior to start to ensure no owls are present. If found, construction would have to be delayed until the owl leaves. Construction should start and all potential nesting borrows should be removed before the bird arrives in the spring. Owl surveys can be completed by the Base Natural Resource Manager.

3.12.2 Bald Eagle (Haliaeetus leucocephalus)

The Bald Eagle has been seen but do not nest at this time on the Facility. The Bald Eagle prey on prairie dogs. The Government recommends avoiding roosting bald eagles by eliminating activity within 75 meters of the roosting bald eagle. However, this is a general recommendation, and may change dependant upon location, available cover, and concealment. It is the Contractor's responsibility to accurately determine appropriate distances to avoid disturbing the Bald Eagle. The Contractor shall ensure that his employees are able to identify bald eagles and shall avoid any disturbance of bald eagles.

3.13 INTEGRATED PEST MANAGEMENT

In order to minimize impacts to existing fauna and flora, the Contractor, through the Contracting Officer, shall coordinate with the Installation Pest Management Coordinator (IPMC) at the earliest possible time prior to pesticide application. The Contractor shall discuss integrated pest management strategies with the IPMC and receive concurrence from the IPMC through the COR prior to the application of any pesticide associated with these specifications. Installation Pest Management personnel shall be given the opportunity to be present at all meetings concerning treatment measures for pest or disease control and during application of the pesticide. The use and management of pesticides are regulated under 40 CFR 152 - 186.

3.13.1 Pesticide Delivery and Storage

Pesticides shall be delivered to the site in the original, unopened containers bearing legible labels indicating the EPA registration number and the manufacturer's registered uses. Pesticides shall be stored according to manufacturer's instructions and under lock and key when unattended.

3.13.2 Qualifications

For the application of pesticides, the Contractor shall use the services of a subcontractor whose principal business is pest control. The subcontractor shall be licensed and certified in the state where the work is to be performed.

3.13.3 Pesticide Handling Requirements

The Contractor shall formulate, treat with, and dispose of pesticides and associated containers in accordance with label directions and shall use the clothing and personal protective equipment specified on the labeling for use during all phases of the application. Material Safety Data Sheets (MSDS)shall be available for all pesticide products.

3.13.4 Application

All pesticide that is applied on Buckley SFB must be reported to the Entomology Shop during the month that it is actually used showing type, quantity, concentration, and location used. Pesticides shall be applied by a State Certified Pesticide Applicator in accordance with EPA label restrictions and recommendation. The Certified Applicator shall wear clothing and personal protective equipment as specified on the pesticide label. Water used for formulating shall only come from locations designated by the Contracting Officer. The Contractor shall not allow the equipment to overflow. Prior to application of pesticide, all equipment shall be inspected for leaks, clogging, wear, or damage and shall be repaired prior to being used.

3.14 PREVIOUSLY USED EQUIPMENT

The Contractor shall clean all previously used construction equipment prior to bringing it onto the project site. The Contractor shall ensure that the equipment is free from soil residuals, egg deposits from plant pests, noxious weeds, and plant seeds. The Contractor shall consult with the USDA jurisdictional office for additional cleaning requirements.

3.15 MAINTENANCE OF POLLUTION FACILITIES

The Contractor shall maintain permanent and temporary pollution control facilities and devices for the duration of the contract or for that length of time construction activities create the particular pollutant.

3.16 MILITARY MUNITIONS

In the event the Contractor discovers or uncovers military munitions as defined in 40 CFR 260, the Contractor shall immediately stop work in that area and immediately inform the Contracting Officer.

3.17 PETROLEUM, OIL, LUBRICANT (POL) STORAGE AND FUELING

POL products include flammable or combustible liquids, such as gasoline, diesel, lubricating oil, used engine oil, hydraulic oil, mineral oil, and cooking oil. Store POL products and fuel equipment and motor vehicles in a manner that affords the maximum protection against spills into the environment. Manage and store POL products in accordance with EPA 40 CFR 112, and other federal, state, regional, and local laws and regulations. Use secondary containments, dikes, curbs, and other barriers, to prevent POL products from spilling and entering the ground, storm or sewer drains, stormwater ditches or canals, or navigable waters of the United States. Describe in the EPP (see paragraph ENVIRONMENTAL PROTECTION PLAN) how POL tanks and containers must be stored, managed, and inspected and what protections must be provided. Storage of fuel on the project site must be in accordance with EPA, state, and local laws and regulations and paragraph OIL STORAGE INCLUDING FUEL TANKS.

3.17.1 Used Oil Management

Manage used oil generated on site in accordance with 40 CFR 279. Determine if any used oil generated while onsite exhibits a characteristic of hazardous waste. Used oil containing 1,000 parts per million of solvents is considered a hazardous waste and disposed of at the Contractor's expense. Used oil mixed with a hazardous waste is also considered a hazardous waste. Dispose in accordance with paragraph HAZARDOUS WASTE DISPOSAL.

3.17.2 Oil Storage Including Fuel Tanks

Provide secondary containment and overfill protection for oil storage tanks. A berm used to provide secondary containment must be of sufficient size and strength to contain the contents of the tanks plus 5 inches freeboard for precipitation. Construct the berm to be impervious to oil for 72 hours that no discharge will permeate, drain, infiltrate, or otherwise escape before cleanup occurs. Use drip pans during oil transfer operations; adequate absorbent material must be onsite to clean up any spills and prevent releases to the environment. Cover tanks and drip pans during inclement weather. Provide procedures and equipment to prevent overfilling of tanks. If tanks and containers with an aggregate aboveground capacity greater than 1320 gallons will be used onsite (only containers with a capacity of 55 gallons or greater are counted), provide and implement a Spill Prevention Control and Countermeasure (SPCC) plan meeting the requirements of 40 CFR 112. Do not bring underground storage tanks to the installation for Contractor use during a project. Submit the SPCC plan to the Contracting Officer for approval.

Monitor and remove any rainwater that accumulates in open containment

dikes or berms. Inspect the accumulated rainwater prior to draining from a containment dike to the environment, to determine there is no oil sheen present.

3.18 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel shall be trained in all phases of environmental protection and pollution control. The Contractor shall conduct environmental protection/pollution control meetings for all Contractor personnel prior to commencing construction activities. Additional meetings shall be conducted for new personnel and when site conditions change. The training and meeting agenda shall include: methods of detecting and avoiding pollution; familiarization with statutory and contractual pollution standards; installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental protection/pollution control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of archaeological sites, artifacts, wetlands, and endangered species and their habitat that are known to be in the area.

3.19 POST CONSTRUCTION CLEANUP

The Contractor shall clean up all areas used for construction in accordance with Contract Clause: "Cleaning Up". The Contractor shall, unless otherwise instructed in writing by the Contracting Officer, obliterate all signs of temporary construction facilities such as haul roads, work area, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the work. The disturbed area shall be graded, filled and the entire area seeded unless otherwise indicated.

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SECTION 01 57 23

TEMPORARY STORM WATER POLLUTION CONTROL
02/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D448	(2012; R 2017) Standard Classification for Sizes of Aggregate for Road and Bridge Construction
ASTM D4873/D4873M	(2017; R 2021) Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 288	(2021) Standard Specification for Geosynthetic Specification for Highway Applications

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA FP-14	(2014) FP-14 Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects

1.2 GENERAL

Implement the storm water pollution prevention measures specified in this section in a manner which will meet the requirements of Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION, and the requirements of the National Pollution Discharge Elimination System (NPDES) permit specified in Section 01 41 26.05 24 NPDES PERMIT REQUIREMENTS FOR STORM WATER DISCHARGES FROM CONSTRUCTION SITES. Install and maintain stabilization and structural best management practices which will minimize erosion and sediment pollution from the construction site to the extent attainable. Maintain responsibility for selection of appropriate best management practices as specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not haveing a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Mill Certificate or Affidavit

1.4 EROSION AND SEDIMENT CONTROLS

The controls and measures required by the Contractor are described in the Storm Water Pollution Prevention Plans (SWPPP) per Section 01 41 26.05 24 NPDES PERMIT REQUIREMENTS FOR STORM WATER DISCHARGES FROM CONSTRUCTION SITES.Reference the Colorado Springs' Stormwater Construction Manual (SCM) in the erosion and sediment control design specifications https:/coloradosprings.gov/stormwater-enterprise/page/stormwater-criteria.

1.4.1 Stabilization Practices

The stabilization practices to be implemented may include temporary seeding, mulching, sod stabilization, vegetative buffer strips, erosion control blankets, protection of trees, preservation of mature vegetation, etc. Record the dates when the major grading activities occur on the daily CQC report; when construction activities temporarily or permanently cease on a portion of the site; and when stabilization practices are initiated.

1.4.1.1 Permanent Seeding

Observe the Buckley SFB Installation Facilities Standards for seed mixtures and vegetation types. Stabilize disturbed areas of the site where construction activities permanently cease with permanent seeding no more than 14 days after the construction activity ceases, except as follows. When the initiation of permanent seeding is stopped due to snow cover or arid conditions, initiate permanent seeding as soon as practicable.

1.4.1.2 Temporary Seeding and Mulching

Temporarily seed and mulch areas where construction activities will temporarily cease for more than one year. Stabilize disturbed areas of the site where construction activities temporarily cease for more than 21 days and less than one year with either temporary seeding and mulching or mulching not more than 14 days after construction activity ceases, except as follows. When the initiation of temporary stabilization measures is stopped due to snow cover or arid conditions, initiate stabilization measures as soon as practicable.

1.4.1.3 Erosion Control Blankets

Erosion control blanket may be installed on steep slopes and in drainage swales and ditches to protect finished grades from erosion.

1.4.2 Temporary Structural Practices

Implement temporary structural practices to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site to the degree attainable. Implement temporary structural practices in a timely manner during the construction process to minimize erosion and sediment runoff. Temporary structural practices shall include but not be limited to the following devices. Location and details of installation and construction are shown on the drawings.

1.4.2.1 Silt Fences

Provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Properly install silt fences to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading). Install silt fence barriers along the down slope boundary of all disturbed areas prior to begining land-distrubing activities in those areas. Silt fence barriers may be installed across ditches or swales but not where the drainage area is greater than 1 acre. Removal of silt fence barriers shall be approved by the Contracting Officer.

1.4.2.2 Storm Drain Inlet Protection

Install storm drain inlet protection at each new and existing inlet which receives storm runoff from disturbed areas of 1 acre of less. Remove the protection at each inlet once the disturbed area has been finally stabilized.

1.4.2.3 Culvert Inlet Protection

Install culvert inlet protection at all culverts with a drainage area of 1 acre or less.

1.4.2.4 Rock Check Dams

Rock check dams may be used to reduce erosion of temporary or permanent ditches or swales. Use type 1 rock check dams when the upstream drainage area is less than 2 acres. Use type 2 rock check dams when the upstream area is 2 to 10 acres.

1.4.2.5 Stone Construction Entrance

Construct a stone construction entrance wherever traffic will be leaving the construction site and move directly onto a paved road. Remove stone construction entrances after the site has been finally stabilized.

1.4.2.6 Sediment Trap

Sediment traps may be constructed below disturbed areas where the total contributing drainage area is less than 3 acres. Sediment traps, when used, should be constructed prior to disturbance of upslope areas. Sediment traps must have an initial storage volume of 134 cubic yards per acre of drainage area, half of which shall be in the form of a permanent pool or wet storage to provide a stable settling medium. The remaining half shall be in the form of a drawdown or dry storage which will provide extended settling time during less frequent, larger storm events.

1.4.2.7 Diversion Dikes

Diversion dikes may be constructed to divert runoff from upslope drainage areas away from unprotected disturbed areas and slopes to a stabiilized outlet or to divert sediment-laden runoff from a disturbed area to a sediment-trapping facility such as a sediment trap or sediment basin. Diversion dikes shall have a maximum channel slope of 2 percent and shall be adequately compacted to prevent failure. The minimum height measured from the top of the dike to the bottom of the channel shall be 18 inches.

The minimum base width shall be 6 feet and the minimum top width shall be 2 feet. The Contractor shall ensure that the diversion dikes are not damaged by construction operations or traffic.

PART 2 PRODUCTS

2.1 COMPONENTS FOR SILT FENCES

2.1.1 Geotextile

The geotextile shall comply with the requirements of AASHTO M 288 for temporary silt fence.

2.1.2 Silt Fence Stakes and Posts

Use either wooden stakes or steel posts for fence construction. Wooden stakes utilized for silt fence construction, shall have a minimum cross section of 2 inches by 2 inches when oak is used and 4 inches by 4 inches when pine is used, and shall have a minimum length of 3 feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction, shall have a minimum weight of 1.33 pounds per linear foot and a minimum length of 5 feet.

2.1.3 Mill Certificate or Affidavit

Provide a mill certificate or affidavit attesting that the geotextile and factory seams meet chemical, physical, and manufacturing requirements specified above. The mill certificate or affidavit shall specify the actual Minimum Average Roll Values and shall identify the fabric supplied by roll identification numbers. Submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the geotextile.

2.1.4 Identification Storage and Handling

Geotextile shall be identified, stored and handled in accordance with ASTM D4873/D4873M.

2.1.5 Support Mesh

Support mesh shall be 14-1/2 gage or heavier steel wire with a mesh spacing of 6 by 6 inch or a prefabricated polymeric mesh of equivalent strength.

2.2 EROSION CONTROL BLANKETS

Installation staple patterns shall be clearly marked on the erosion control blanket with environmentally safe paint.

2.2.1 Netless Erosion Control Blanket

Erosion control blankets shall be a machine-produced mat with a biodegradable agricultural straw matrix (approximately 0.50 lb/sq yd). The blanket shall have a 12-month typical functional longevity and be designed for use on geotechnically stable slopes with gradients up to 1V:4H and channels with shear stresses up to 0.50 pounds per square foot.

2.2.2 Single-Net Erosion Control Blanket

Erosion control blankets shall be a machine-produced mat with a biodegradable agricultural straw matrix (approximately 0.50 lb/sq yd) and photodegradable netting on the top side. The blanket shall be sewn together with degradable thread. The blanket shall have a 12-month typical functional longevity and be designed for use on geotechnically stable slopes with gradients up to 1V:3H and channels with shear stresses up to 1.50 pounds per square foot.

2.2.3 Double-Net Erosion Control Blanket

Erosion control blankets shall be a machine-produced mat with a biodegradable agricultural straw matrix (approximately 0.50 lb/sq yd) and photodegradable netting on each side. The blanket shall be sewn together with degradable thread. The blanket shall have a 12-month typical functional longevity and be designed for use on geotechnically stable slopes with gradients up to 1V:2H and channels with shear stresses up to 1.75 pounds per square foot.

2.3 PERMANENT TURF REINFORCEMENT MAT

Turf reinforcement matting shall conform to FHWA FP-14, Section 713, Type 5.A.

2.4 COMPONENTS FOR SEDIMENT TRAP

Coarse aggregate shall conform to ASTM D448, Size 3, 357, or 5. Minor variations from the gradations specified will be permitted. Stone for riprap shall consist of field stone or rough unhewn quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering. The specific gravity of individual stones shall be at least 2.5. Riprap stones shall weigh between 50 and 150 pounds each, except that approximately 10 percent may weigh 50 pounds or less. At least 60 percent shall weight more than 100 pounds. Geotextile shall conform to paragraph GEOTEXTILES.

2.5 COMPONENTS FOR INLET PROTECTION

Aggregates for gravel filter should be sized to get the greatest amount of filtering action possible (by using smaller-sized stone), while not creating significant ponding problems.

2.6 STONE CONSTRUCTION ENTRANCE

Aggregate for construction entrance shall conform to ASTM D448, Size 1. Minor variations from the gradation specified will be permitted. Geotextile shall conform to paragraph GEOTEXTILES.

2.7 ROCK CHECK DAMS

Coarse aggregate shall conform to ASTM D448 size number 1 or approved equal. Riprap shall consist of field stone or rough unhewn quarry stone of approximately rectangular shape. Riprap shall be hard and angular. The specific gravity of individual stones shall be at least 2.5. Concrete rubble may be used provided it has a density of at least 150 pcf. Individual stones shall have a weight of 50 to 150 lbs except that a maximum of 10 percent of stone may weigh less than 50 lbs. At least 60

percent of stones shall weigh more than 100 lbs.

2.8 GEOTEXTILES

Geotextile for other than silt fence shall comply with the requirements of AASHTO M 288 for a separation geotextile.

PART 3 EXECUTION

3.1 INSTALLATION OF SILT FENCES

Silt fences shall extend a minimum of 16 inches above the ground surface and shall not exceed 34 inches above the ground surface. Geotextile shall be from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, geotextile shall be spliced together at a support post, with a minimum 6 inch overlap, and securely sealed. Silt fence may be installed using either the trench or soil slicing method. Silt fences shall be removed upon approval by the Contracting Officer.

3.2 EROSION CONTROL BLANKETS

Installation of erosion control blankets shall conform to the manufacturer's recommendations.

3.3 TURF REINFORCEMENT MAT

Installation of turf reinforcement matting shall conform to the manufacturer's recommendations.

3.4 SEDIMENT TRAP

The area under the embankment shall be cleared, grubbed, and stripped of any vegetation and root mat. Fill material for the embankment shall be placed in accordance with Section 31 00 00 EARTHWORK. A geotextile shall be placed between the riprap and subgrade.

3.5 STONE CONSTRUCTION ENTRANCE

The area of the entrance shall be cleared of all vegatation, roots, and other objectionable material. The aggregate layer shall have a minimum total thickness of 6 inches. A geotextile shall be placed beneath aggregate for the full width and length of the entrance. A minimum of 3 inches of the aggregate shall be placed in a cut section to provide stability and secure the geotextile. If conditions on the site are such that the majority of the mud is not removed by the vehicles traveling over the stone, then the tires of the vehicles shall be washed before entering the road. Wash water must be carried away from the entrance to an approved settling area to remove sediment. A wash rack may also be installed for washing of vehicles.

3.6 MAINTENANCE

Maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. The following procedures shall be followed to

maintain the protective measures.

3.6.1 Silt Fences

Inspect silt fences in accordance with paragraph INSPECTIONS. Make any required repairs promptly. Pay close attention to the repair of damaged silt fence resulting from end runs and undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, replace the fabric promptly. Remove sediment deposits when deposits reach one-third of the height of the barrier. Remove silt fence when it is no longer required. Shape the immediate area occupied by the fence and any sediment deposits to an acceptable grade. Seed the areas disturbed by this shaping in accordance with Section 32 92 19 SEEDING.

3.6.2 Storm Drain Inlet Protection

Inspect inlet protection structures after each rainfall and make repairs as needed. Remove sediment and restore the trap to its original dimensions when the sediment has accumulated to one half the design depth.

3.6.3 Rock Check Dams

Check dams should be checked for sediment after each runoff-producing storm event. Remove sediment when it reaches one half the original height of the measure.

3.6.4 Stone Construction Entrance

Maintain stone construction entrances in a conditon which will prevent tracking or flow of mud onto paved roads. This may require periodic top dressing with additional stone or the washing and reworking of existing stone as conditions demand and repair and/or cleanout of any structures used to trap sediment. The use of water trucks to remove materials dropped, washed, or tracked onto roadways will not be permitted under any circumstances.

3.6.5 Sediment Traps

Remove sediment restore the trap to its original dimensions when the sediment has accumulated to one half the design volume of the wet storage. Check filter stone regularly to ensure that filtration performance is maintained. Remove stone choked with sediment and clean or replace. Inspect the structure regularly to ensure that it is structurally sound and has not been damaged by erosion or construction equipement. Inspect the height of the stone outlet to ensure that its center is a least 1 foot below the top of the embankment.

3.6.6 Diversion Dikes

Inspect diversion dikes in accordance with paragraph INSPECTIONS. Pay close attention to the repair of damaged diversion dikes and promptly accomplish necessary repairs. When diversion dikes are no longer required, they shall be shaped to an acceptable grade. Seed the areas disturbed by this shaping in accordance with Section 32 92 19 SEEDING.

3.7 INSPECTIONS

3.7.1 General

Inspect disturbed areas of the construction site, areas used for storage of materials that are exposed to precipitation that have not been finally stabilized, stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site. Where sites have been finally stabilized, conduct such inspection at least once every month. Inspection of protective measures shall conform to the requirements in the SWPPP.

3.7.2 Inspections Details

Inspect disturbed areas and areas used for material storage that are exposed to precipitation for evidence of, or the potential for, pollutants entering the drainage system. Observe erosion and sediment control measures to ensure that they are operating correctly. Inspect discharge locations or points to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Inspect locations where vehicles exit the site for evidence of offsite sediment tracking.

3.7.3 Inspection Reports

For each inspection conducted, prepare a report summarizing the scope of the inspection, name(s) of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the storm water pollution prevention measures, maintenance performed, and actions taken. Furnish the report to the Contracting Officer within 24 hours of the inspection as a part of the Contractor's daily CQC REPORT.

-- End of Section --

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SECTION 01 62 35

RECYCLED / RECOVERED MATERIALS

07/06

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PART 2 PRODUCTS

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-- End of Section Table of Contents --

SECTION 01 62 35

RECYCLED / RECOVERED MATERIALS

07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247	Comprehensive Procurement Guideline for Products Containing Recovered Materials

1.2 OBJECTIVES

Government procurement policy is to acquire, in a cost effective manner, items containing the highest percentage of recycled and recovered materials practicable consistent with maintaining a satisfactory level of competition without adversely affecting performance requirements or exposing suppliers' employees to undue hazards from the recovered materials. The Environmental Protection Agency (EPA) has designated certain items which must contain a specified percent range of recovered or recycled materials. EPA designated products specified in this contract comply with the stated policy and with the EPA guidelines. Make all reasonable efforts to use recycled and recovered materials in providing the EPA designated products and in otherwise utilizing recycled and recovered materials in the execution of the work.

1.3 EPA DESIGNATED ITEMS INCORPORATED IN THE WORK

Various sections of the specifications contain requirements for materials that have been designated by EPA as being products which are or can be made with recovered or recycled materials. These items, when incorporated into the work under this contract, shall contain at least the specified percentage of recycled or recovered materials unless adequate justification (non-availability) for non-use is provided. When a designated item is specified as an option to a non-designated item, the designated item requirements apply only if the designated item is used in the work.

1.4 EPA PROPOSED ITEMS INCORPORATED IN THE WORK

Products other than those designated by EPA are still being researched and are being considered for future Comprehensive Procurement Guideline (CPG) designation. It is recommended that these items, when incorporated in the work under this contract, contain the highest practicable percentage of recycled or recovered materials, provided specified requirements are also met.

1.5 EPA LISTED ITEMS USED IN CONDUCT OF THE WORK BUT NOT INCORPORATED IN THE WORK

There are many products listed in 40 CFR 247 which have been designated or proposed by EPA to include recycled or recovered materials that may be used by the Contractor in performing the work but will not be incorporated into the work. These products include office products, temporary traffic control products, and pallets. It is recommended that these non-construction products, when used in the conduct of the work, contain the highest practicable percentage of recycled or recovered materials and that these products be recycled when no longer needed.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

02/19, CHG 3: 11/21

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SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
02/19, CHG 3: 11/21

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 Co-mingle

The practice of placing unrelated materials together in a single container, usually for benefits of convenience and speed.

1.1.2 Construction Waste

Waste generated by construction activities, such as scrap materials, damaged or spoiled materials, temporary and expendable construction materials, and other waste generated by the workforce during construction activities.

1.1.3 Demolition Debris/Waste

Waste generated from demolition activities, including minor incidental demolition waste materials generated as a result of Intentional dismantling of all or portions of a building, to include clearing of building contents that have been destroyed or damaged.

1.1.4 Disposal

Depositing waste in a solid waste disposal facility, usually a managed landfill or incinerator, regulated in the US under the Resource Conservation and Recovery Act (RCRA).

1.1.5 Diversion

The practice of diverting waste from disposal in a landfill or incinerator, by means of eliminating or minimizing waste, or reuse of materials.

1.1.6 Final Construction Waste Diversion Report

A written assertion by a material recovery facility operator identifying constituent materials diverted from disposal, usually including summary tabulations of materials, weight in short-ton.

1.1.7 Recycling

The series of activities, including collection, separation, and processing, by which products or other materials are diverted from the solid waste stream for use in the form of raw materials in the manufacture of new products sold or distributed in commerce, or the reuse of such materials as substitutes for goods made of virgin materials, other than fuel.

1.1.8 Reuse

The use of a product or materials again for the same purpose, in its original form or with little enhancement or change.

1.1.9 Salvage

Usable, salable items derived from buildings undergoing demolition or deconstruction, parts from vehicles, machinery, other equipment, or other components.

1.1.10 Source Separation

The practice of administering and implementing a management strategy to identify and segregate unrelated waste at the first opportunity.

1.2 CONSTRUCTION WASTE (INCLUDES DEMOLITION DEBRIS/WASTE)

Divert a minimum of 60 percent by weight of the project construction waste and demolition debris/waste from the landfill or incinerator. Follow applicable industry standards in the management of waste. Apply sound environmental principles in the management of waste. (1) Practice efficient waste management when sizing, cutting, and installing products and materials and (2) use all reasonable means to divert construction waste and demolition debris/waste from landfills and incinerators and to facilitate the recycling or reuse of excess construction materials.

1.3 CONSTRUCTION WASTE MANAGEMENT

Implement a Construction Waste Management Program for the project. Take a pro-active, responsible role in the management of construction construction waste, recycling process, disposal of demolition debris/waste, and require all subcontractors, vendors, and suppliers to participate in the Construction Waste Management Program. Establish a process for clear tracking, and documentation of construction waste and demolition debris/waste.

1.3.1 Implementation of Construction Waste Management Program

Develop and document how the Construction Waste Management Program will be implemented in a Construction Waste Management Plan. Submit a Construction Waste Management Plan to the Contracting Officer for approval. Construction waste and demolition debris/waste materials include unused construction materials not incorporated in the final work, as well as demolition debris/waste materials from demolition activities or deconstruction activities. In the management of waste, consider the availability of viable markets, the condition of materials, the ability to provide material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates.

1.3.2 Oversight

The Quality Control Manager, as specified in Section 01 45 00 QUALITY CONTROL, is responsible for overseeing and documenting results from executing the Construction Waste Management Plan for the project.

1.3.3 Special Programs

Implement any special programs involving rebates or similar incentives related to recycling of construction waste and demolition debris/waste materials. Retain revenue or savings from salvaged or recycling, unless otherwise directed. Ensure firms and facilities used for recycling, reuse, and disposal are permitted for the intended use to the extent required by federal, state, and local regulations.

1.3.4 Special Instructions

Provide on-site instruction of appropriate separation, handling, recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the projects. Designation of single source separating or commingling will be clearly marked on the containers.

1.3.5 Waste Streams

Delineate waste streams and characterization, including estimated material types and quantities of waste, in the Construction Waste Management Plan. Manage all waste streams associated with the project. Typical waste streams are listed below. Include additional waste steams not listed:

a. Land Clearing Debris
b. Asphalt
c. Masonry and CMU
d. Concrete
e. Metals (e.g. banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized, stainless steel, aluminum, copper, zinc, bronze, etc.)
f. Wood (nails and staples allowed)
g. Glass
h. Paper
i. Plastics (PET, HDPE,PVC,LDPE,PP,PS, Other)
j. Gypsum
k. Non-hazardous paint and paint cans
l. Carpet
m. Ceiling Tiles
n. Insulation
o. Beverage Containers

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Construction Waste Management Plan; G-RO

SD-11 Closeout Submittals

Final Construction Waste Diversion Report; G-RO

1.5 MEETINGS

Conduct Construction Waste Management meetings. After award of the Contract and prior to commencement of work, schedule and conduct a meeting with the installation Hazardous Waste Program Manager and the Contracting Officer to discuss the proposed Construction Waste Management Plan and to develop a mutual understanding relative to the management of the Construction Waste Management Program and how waste diversion requirements will be met.

The requirements of this meeting may be fulfilled during the coordination and mutual Understanding meeting outlined in Section 01 45 00 QUALITY CONTROL. At a minimum, discuss and document waste management goals at following meetings:

a. Preconstruction meeting.

b. Regular Quality Control meetings.

c. Work safety meeting (if applicable).

1.6 CONSTRUCTION WASTE MANAGEMENT PLAN

Submit Construction Waste Management Plan within 30 calendar days after notice to proceed. Revise and resubmit Construction Waste Management Plan until it receives final approval from the installation Hazardous Waste Program Manager and the Contracting Officer, in order for construction to begin. Execute demolition or deconstruction activities in accordance with Section 02 41 00 DEMOLITION AND DECONSTRUCTION. Manage demolition debris/waste or deconstruction materials in accordance with the approved Construction Waste Management Plan.

An approved Construction Waste Management Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations or meeting project cumulative waste diversion requirement. Ensure all subcontractors receive a copy of the approved Construction Waste Management Plan. The plan demonstrates how to meet the project waste diversion requirement. Also, include the following in the plan:

a. Identify the names of individuals responsible for waste management and waste management tracking, along with roles and responsibilities on the project.

b. Actions that will be taken to reduce solid waste generation, including coordination with subcontractors to ensure awareness and participation.

c. Description of the regular meetings to be held to address waste management.

d. Description of the specific approaches to be used in recycling of the various materials generated, including the areas on site and equipment to be used for processing, sorting, and temporary storage of materials.

e. Name of landfill and/or incinerator to be used.

f. Identification of local and regional re-use programs, including non-profit organizations such as schools, local housing agencies, and organization that accept used materials such as material exchange networks and resale stores. Include the name, location, phone number

for each re-use facility identified, and provide a copy of the permit or license for each facility.

g. List of specific materials, by type and quantity, that will be recycled. Identify the recycling facilities by name, address, and phone number.

h. Identification of materials that cannot be recycled or reused with an explanation or justification.

i. Description of the means by which any materials identified in item (g) above will be protected from contamination.

j. Description of the means of transportation of the recyclable materials (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site).

k. Copy of training plan for subcontractors and other services to prevent contamination by co-mingling materials identified for diversion and waste materials.

Distribute copies of the waste management plan to each subcontractor, Quality Control Manager, and the Contracting Officer.

1.7 RECORDS (DOCUMENTATION)

1.7.1 General

Maintain records to document the types and quantities of waste generated and diverted though re-use, recycling and/or sale to third parties; through disposal to a landfill or incinerator facility. Provide explanations for any materials not recycled, reused or sold. Collect and retain manifests, weight tickets, sales receipts, and invoices specifically identifying diverted project waste materials or disposed materials.

1.7.2 Accumulated

Maintain a running record of materials generated and diverted from landfill disposal, including accumulated diversion rates for the project. Make records available to the Contracting Officer and installation POC during construction or incidental demolition activities. Provide a copy of the diversion records to the Contracting Officer and installation POC upon completion of the construction, incidental demolitions or minor deconstruction activities.

1.8 FINAL CONSTRUCTION WASTE DIVERSION REPORT

A Final Construction Waste Diversion Report is required at the end of the project. Provide Final Construction Waste Diversion Report 60 days prior to the Beneficial Occupancy Date (BOD).

1.9 COLLECTION

Collect, store, protect, and handle reusable and recyclable materials at the site in a manner which prevents contamination, and provides protection from the elements to preserve their usefulness and monetary value. Provide receptacles and storage areas designated specifically for recyclable and

reusable materials and label them clearly and appropriately to prevent contamination from other waste materials. Keep receptacles or storage areas neat and clean.

Train subcontractors and other service providers to either separate waste streams or use the co-mingling method as described in the Construction Waste Management Plan. Handle hazardous waste and hazardous materials in accordance with applicable regulations and other applicable contract requirements. Separate materials by one of the following methods described herein:

1.9.1 Source Separation Method

Separate waste products and materials that are recyclable from trash and sort as described below into appropriately marked separate containers and then transport to the respective recycling facility for further processing. Deliver materials in accordance with recycling or reuse facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process). Separate materials into the category types as defined in the Construction Waste Management Plan.

1.9.2 Other Methods

Other methods proposed by the Contractor may be used when approved by the Contracting Officer.

1.10 DISPOSAL

Control accumulation of waste materials and trash. Recycle or dispose of collected materials off-site at intervals approved by the Contracting Officer, in compliance with paragraph 1.4 of this section, and and in compliance with waste management procedures as described in the waste management plan. Except as otherwise specified in other sections of the specifications, recyle or dispose of in accordance with the following:

1.10.1 Recycle

Recycle non-hazardous construction and demolition/debris materials that are not suitable for reuse. Track rejection of contaminated recyclable materials by the recycling facility. Rejected recyclables materials will not be counted as a percentage of diversion calculation.

1.10.2 HAZMART Disposal

Dispose of all fluorescent lamps, HID lamps, mercury (Hg) containing thermostats and ampoules through the HAZMART as a Universal Waste. Do not crush lamps on site as this creates a hazardous waste stream with additional handling requirements. Dispose of PCBs containing ballasts and electrical components through the HAZMART. Properly collect and containerize in DOT-approved shipping containers, also approved by the HWMP, universal waste and PCBs. Properly label the containers in accordance with all federal regulations. Deliver all universal waste and PCBs requiring disposal to the HAZMART.

1.10.3 Waste

Dispose by landfill or incineration only those waste materials not listed above with no practical use, economic benefit, or recycling opportunity.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used. -- End of Section --

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SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

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SECTION 01 78 23

OPERATION AND MAINTENANCE DATA
05/23, OMH, CHG 1: 05/25

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE GUIDELINE 1.4	(2019) Preparing Systems Manuals for Facilities

ASTM INTERNATIONAL (ASTM)

ASTM E1971	(2024) Standard Guide for Stewardship for the Cleaning of Commercial and Institutional Buildings
ASTM E2166	(2016; R 2023) Standard Practice for Organizing and Managing Building Data

1.2 SUSTAINABILITY REQUIREMENTS

Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for project requirements.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-10 Operation and Maintenance Data

Training Plan; G, RO

Training Outline; G, RO

Training Content; G, RO

Operation And Maintenance Manual, Progress Submittal; G, RO

Operation And Maintenance Manual, Prefinal Submittal; G, RO

Operation And Maintenance Manual, Final Submittal; G, RO

SD-11 Closeout Submittals

Training Video Recording; G, RO

Validation of Training Completion; G, RO

Training Plan; G, RO

Record Drawings And Utility Systems; G, RO

FACILITY DATA WORKBOOK; G, RO

1.4 MEETINGS

To assure that Operation and Maintenance Manual and Facility Data Workbook requirements are being met through the duration of the project, organize the following meetings and discuss the subsequent topics:

1.4.1 Pre-Construction Meeting

At a minimum, discuss the following:

a. The requirement for Operation and Maintenance Manuals and Facility Data deliverables under this contract including coordination meetings

b. Processes and method of gathering Facility Data information during construction

c. Primary roles and responsibilities associated with the development and delivery of the Operation and Maintenance Manuals and Facility Data deliverables, and

d. Identify and agree upon a date and attendance list for the meetings described below:

1.4.2 Operation and Maintenance Manual and Facility Data Workbook Coordination Meeting

Facilitate a meeting after the Pre-Construction Meeting prior to the submission of the Operation and Maintenance Manual Progress Submittal. Meeting attendance must include the Contractor's Operation and Maintenance Manual and Facility Data Workbook Preparer, Quality Control Manager, the Commissioning Authority (CxA), the Government's Design Manager (DM), Contracting Officer's Representative, and Government's facility data reviewer. Include any Mechanical, Electrical, and Fire Protection Sub-Contractors.

The purpose of this meeting is to reach a mutual understanding of the scope of work concerning the contract requirements for Operation and Maintenance Manual and coordinate the efforts necessary by both the Government and Contractor to ensure an accurate collection, preparation and timely Government review of Operation and Maintenance Manual.

1.4.3 Submittal Coordination Meeting

Facilitate a meeting following submission and Government review of each design or progress submittal of the Operation and Maintenance Manual and Facility Data Workbook.

a. Include personnel from the Coordination meeting and any additional

personnel identified.

b. The purpose of this meeting is to demonstrate ongoing compliance with the requirements identified in this specification. Discuss Government review comments and unresolved items preventing completion and Government approval of the Operation and Maintenance Manuals and Facility Data Workbook (FDW).

c. The applicable deliverables, along with Government remarks associated with review of these submittals serve as the primary guide and agenda for this meeting.

1.5 FACILITY DATA WORKBOOK

Develop an editable, electronic spreadsheet based on the equipment in the Operation and Maintenance Manuals that contains the information required to start a preventive maintenance program as outlined in 01 78 24.00 10 FACILITY DATA REQUIREMENTS.

1.6 OPERATION AND MAINTENANCE MANUAL MEDIA

Assemble Operation and Maintenance Manual into an electronically bookmarked file using the most current version of Adobe Acrobat or similar software capable of producing PDF file format. Provide compact disks (CD) or data digital versatile disk (DVD) as appropriate, so that each one contains operation, maintenance and record files, project record documents, and training videos. Include a complete bookmarked operation and maintenance directory.

1.6.1 CD or DVD Label and Disk Holder or Case

Provide the following information on the disk label and disk holder or case:

a. Building Number

b. Project Title

c. Activity and Location

d. Construction Contract Number

e. Prepared For: (Contracting Agency)

f. Prepared By: (Name, title, phone number and email address)

g. Include the disk content on the disk label

h. Date

i. Virus scanning program used

1.6.2 O&M Manual Tabbed Hard Copy

Provide a hard copy of the O&M manual upon completion of the project. Provide tabs for each section and subsection for ease of navigation by the user.

1.7 O&M MANUAL CONTENT

Organize the bookmarked Operation and Maintenance Manual into the following Parts in accordance with ASHRAE GUIDELINE 1.4, and as modified and detailed below. Word template for O&M Manual is available at: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-01-78-23.

1.7.1 Part 1: Executive Summary

Provide a summary of the information found in the O&M manual including the purpose of the manual and a description of the manual's organization.

1.7.2 Part 2: Facility Design and Construction

1.7.2.1 General Facility and Systems Description

Provide an overview of the intent for design and use of the facility. Provide a PDF of the Record Drawings prepared in accordance with 01 78 39.00 24 AS-BUILT DRAWINGS and bookmarked using the sheet title and sheet number. Include uncluttered 11 by 17 inches floor plans with room numbers, type or function of space, and overall facility dimensions on the floor plans. Do not include items such as construction instructions, references, or frame numbers.

Detail the overall dimensions of the facility, number of floors, foundation type, expected number of occupants, and facility Category Code list and generally describe all the facility systems and any special building features (for example, HVAC Controls, Sprinkler Systems, Cranes, Elevators, and Generators). Include photographs marked up and labeled to show key operating components and the overall facility appearance.

1.7.2.2 Basis of Design

Provide a copy of the contract Basis of Design.

1.7.2.3 Contract Documents, RFP, Amendments, and Modifications

Provide the contract construction documents complete, to include specifications, drawings, Request for Proposal, amendments, and modifications.

1.7.3 Part 3: Facilities, Systems, and Assemblies Information

1.7.3.1 Organization

Bookmark information in this section using the current version of ASTM E2166 Uniformat II, UFGS numbers, and document type as outlined in the example below. Bookmark/tab each item to the third level for easy navigation of the manual.

Example as shown in Table below:

PARTS AND SUBPART NUMBERING
3.1 B20 EXTERIOR CLOSURE (System)

PARTS AND SUBPART NUMBERING
3.1.1 B2030 EXTERIOR DOORS (Subsystem)
3.1.1.1 B2030110 GLAZED DOORS (Component)
3.1.1.1.1 Applicable specifications List in UFGS Format
3.1.1.1.2 Manufacturer's Operations and Maintenance Data
3.1.1.1.3 Approved Submittal
3.1.1.1.4 Coordination/Shop Drawings
3.1.1.1.5 Sequence of Operation for Operating Equipment
3.1.1.1.6 Testing Equipment Information and Performance Data
3.1.1.1.7 Routine Maintenance Requirements
3.1.1.1.8 Repair Procedures
3.1.1.1.9 Emergency Procedures & Locations of Applicable Controls
3.1.1.1.10 Warranties
3.1.1.1.11 Record Drawings and Utility Systems
3.1.1.1.12 Contractor / Supplies Listing and Contact Information

1.7.3.2 Related Specifications

Reference each specification related to the subsystem in this section, and locate the actual specification section in Part 2 of the O&M Manual. List specifications in table format as shown in the below example.

UFGS Number	Specification Title	Page Spec Begins in Part 2

1.7.3.3 Manufacturer's Operations and Maintenance Data

Provide a copy of all manufacturer specifications and cutsheets. Provide text-searchable, high-quality document files from the manufacturer's online or electronic documentation. Color documents are preferred. Provide documents specific to the product(s) installed under this Contract. Provide identification and coverage for the parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Provide Uniformat II Level 3 identification for D20, D30, D40 installed equipment. When possible, do not submit document files containing multiple product catalogs from the same manufacturer, or product data from multiple manufacturers in the same files. Provide documents directly from the manufacturer whenever possible. Do not provide scanned copies of hardcopy documents. Provide identification and coverage for the parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware

requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing must show the index, reference, or key number that will cross-reference the illustrated part to the listed part. Group the parts shown in the listings by components, assemblies, and subassemblies in accordance with the manufacturer's standard practice. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as typically shown in a master part catalog.

1.7.3.4 Approved Submittals and Certificates

Provide a copy of all submittals documented with the required approval as applicable for each UFGS specification listed in the table outlined in applicable specifications. Include copies of SD-07 Certificates submittals documented with the required approval, SD-08 Manufacturer's Instructions submittals documented with the required approval, and SD-10 Operation and Maintenance Data submittals documents with the required approval.

1.7.3.5 Approved Coordination/Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work. Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project. Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

1.7.4 Sequence of Operation for Operating Equipment

Provide record one-line diagrams for each floor, delineating mechanical equipment location within the building. Provide specific instructions, procedures, and illustrations for the following phases of operation for the installed model and features of each system:

1.7.4.1 Safety Precautions and Hazards

List personnel hazards and equipment or product safety precautions for operating conditions. List all residual hazards identified in the Activity Hazard Analysis provided under Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS. Provide recommended safeguards for each identified hazard. Specify if any certifications or licenses are required to operate the equipment.

1.7.4.2 Operator Prestart

Provide procedures required to install, set up, and prepare each system for use.

1.7.4.3 Startup, Shutdown, and Post-Shutdown Procedures

Provide narrative description for Startup, Shutdown and Post-shutdown operating procedures including the control sequence for each procedure.

1.7.4.4 Normal Operations

Provide Control Diagrams with data to explain operation and control of systems and specific equipment. Provide narrative description of Normal Operating Procedures.

1.7.4.5 Emergency Operations

Provide Emergency Procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Provide Emergency Shutdown Instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance and procedures for emergency operation of utility systems including required valve positions, valve locations and zones or portions of systems controlled.

1.7.4.6 Operator Service Requirements

Provide instructions for services to be performed by the operator such as lubrication, adjustment, inspection, and recording gauge readings.

1.7.4.7 Environmental Conditions

Provide a list of Environmental Conditions (temperature, humidity, and other relevant data) that are best suited for the operation of each product, component or system. Describe conditions under which the item equipment should not be allowed to run.

1.7.4.8 Operating Log

Provide forms, sample logs, and instructions for maintaining necessary operating records.

1.7.4.9 Additional Requirements for Equipment Control Systems

Provide Data Package 5 and the following for all control systems:

a. Provide a narrative description on how to perform and apply functions, features, modes, and other operations, including unoccupied operation, seasonal changeover, manual operation, and alarms. Include detailed technical manual for programming and customizing control loops and algorithms.

b. Submit complete controls equipment schedules, full as-built sequence of operations, wiring and logic diagrams, Input/Output Tables, equipment schedules, copies of checkout tests and calibrations performed by the Contractor (not Cx tests), and all associates information.

c. Full points list. Provide a listing of rooms with the following information for each room:

(1) Floor

(2) Room number

(3) Room name

(4) Air handler unit ID

(5) Reference drawing number

(6) Air terminal unit tag ID

(7) Heating or cooling valve tag ID

(8) Minimum cfm

(9) Maximum cfm

d. Full print out of all schedules and set points after testing and acceptance of the system.

e. Full as-built print out of software program.

f. Marking of system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

1.7.4.10 Testing Equipment Information and Performance Data

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components. Provide final set points.

Include completed prefunctional checklists, functional performance test forms, and monitoring reports. Include recommended schedule for retesting and blank test forms. Provide final set points.

1.7.5 Routine Maintenance Requirements

1.7.5.1 Preventive Maintenance Plan, Schedule, and Procedures

Provide manufacturer's schedule for routine preventive maintenance, inspections, condition monitoring (predictive tests) and adjustments required to ensure proper and economical operation and to minimize repairs. Provide instructions stating when the systems should be retested. Provide manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including requirements by type of activity. For periodic calibrations, provide manufacturer's specified frequency and procedures for each separate operation.

a. Define the anticipated time required to perform each of each test (work-hours), test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements within the schedule. Provide a remarks column for the testing validation procedure referencing operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Delineate procedures for preventive maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize repairs.

b. Repair requirements must inform operators how to check out, troubleshoot, repair, and replace components of the system. Include electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting of the system after acceptance.

1.7.5.2 Lubrication Data

Include the following preventive maintenance lubrication data, in addition to instructions for lubrication required under paragraph OPERATOR SERVICE REQUIREMENTS:

a. A table showing recommended lubricants for specific temperature ranges and applications.

b. Charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities. Provide procedural instructions for Oil Sampling for all equipment.

c. A Lubrication Schedule showing service interval frequency.

1.7.6 Repair Procedures

Provide instructions and a list of tools required to repair or restore the product or equipment to proper condition or operating standards. Provide manufacturer's recommended procedures and instructions for correcting problems and making repairs for the installed model and features of each system. Include potential environmental and indoor air quality impacts of recommended maintenance procedures and materials. Specify if any certifications or licenses are required to repair the equipment.

1.7.6.1 Troubleshooting Guides and Diagnostic Techniques

Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

1.7.6.2 Wiring Diagrams and Control Diagrams

Provide point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to actual installation configuration and numbering.

1.7.6.3 Removal and Replacement Instructions

Provide step-by-step procedures and a list of required specialty tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Use a combination of text and illustrations.

1.7.6.4 Repair Work-Hours

Provide manufacturer's projection of repair work-hours including requirements by type of craft. Identify, and tabulate separately, repair that requires the equipment manufacturer to complete or to participate.

1.7.6.5 Warranty Information

List and explain the various warranties and clearly identify the servicing and technical precautions prescribed by the manufacturers or contract documents in order to keep warranties in force. Identify if replacement of a subassembly, attachment or accessory requires the entire assembly to be replaced. Include warranty information for primary components of the system. Provide copies of warranties required by Section 01 78 36.00 24 WARRANTY OF CONSTRUCTION.

1.7.6.6 Extended Warranty Information

List all warranties for products, equipment, components, and sub-components whose duration exceeds one year. For each warranty listed, indicate the applicable specification section, duration, start date, end date, and the point of contact for warranty fulfillment. Also, list or reference the specific operation and maintenance procedures that must be performed to keep the warranty valid. Provide copies of warranties required by Section 01 78 36.00 24 WARRANTY OF CONSTRUCTION.

1.7.6.7 Record Drawings and Utility Systems

The record drawings are the final compilation of actual conditions reflected in the as-built drawings. Provide record drawings as outlined in 01 78 39.00 24 AS-BUILT DRAWINGS.

Using Record Source Drawings, show and document details of the actual installation of the utility systems, annotate and highlight the Operation and Maintenance information. Provide the following drawings at a large enough scale to differentiate designated isolation units from surrounding valves and switches.

1.7.6.8 Personnel Training Requirements

Provide information available from the manufacturers that is needed for use in training designated personnel to properly operate and maintain the equipment and systems.

1.7.6.9 Contractor / Supplier Listing and Contact Information

Provide a list that includes the name, address, telephone number, email and website of the General Contractor and each Subcontractor who installed the product or equipment, or system. For each item, also provide the name address and telephone number of the manufacturer's representative and service organization that can provide replacements most convenient to the project site. Provide the name, address, and telephone number of the product, equipment, and system manufacturers.

1.7.7 Part 4: Facility Operations

1.7.7.1 Completed Facility Operating Plan

Provide a plan that documents that procedures for the operation of systems and assemblies in the facility. The systems that should be included in the Operating Plan include, but are not limited to:

a. Electrical systems and equipment

b. Mechanical systems and equipment

c. Fire Protection systems and equipment

d. Control Systems and equipment

e. Architectural and Structural systems, fixtures, structures, and equipment

f. Vertical transportation such as elevators and escalators

1.7.7.2 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components. Provide final set points.

1.7.7.3 Testing and Performance Data

Include completed prefunctional checklists, functional performance test forms, and monitoring reports. Include recommended schedule for retesting and blank test forms. Provide final set points.

1.7.7.4 Approved Field Test Reports and Manufacturer's Field Reports

Compile and provide approved Field Test Reports (SD-06) and Manufacturer's Field Reports (SD-09) submittals.

1.7.7.5 Maintenance Plans, Procedures, Checklists, Records, and Spare Parts Inventory

1.7.7.5.1 Maintenance Schedules

Include recommended maintenance schedules for systems and equipment.

1.7.7.5.2 Ongoing Commissioning Operational and Maintenance Record Keeping

Include ongoing commissioning and optimization procedures and documentation to monitor and improve the performance of facility systems.

1.7.7.5.3 Janitorial and Cleaning Plans and Procedures

Include a copy of facility cleaning and janitorial plan with procedures and intended chemicals and equipment.

Provide environmentally friendly cleaning recommendations in accordance with ASTM E1971.

1.7.7.6 Utility Record Drawings

1.7.7.6.1 Utility Schematic Diagrams

Provide a one-line schematic diagram for each utility system such as power, water, wastewater, and gas/fuel. Schematic diagram must show from the point where the utility line is connected to the mainline up to the 5 foot connection point to the facility. Indicate location or area designation for route of transmission or distribution lines; locations of duct banks, manholes/handholes or poles; isolation units such as valves and switches; and utility facilities such as pump stations, lift stations, and substations.

1.7.7.6.2 Enlarged Connection and Cutoff Plans

Provide enlarged floor plans and provide information between the 5 foot utilities connection point and where utilities connect to facility distribution. Enlarge floor plans/elevations of the rooms where the utility enters the building and indicate on these plans the locations of the main interiors and exterior connection and cutoff points for the utilities. Also enlarge floor plans/elevations of the rooms where equipment is located. Include enough information to enable someone unfamiliar with the facility to locate the connection and cutoff points. Indicate designations such as room number, panel number, circuit breaker, or valve number of each utility and equipment connection and cutoff point, and what that connection and cutoff point controls.

1.7.7.6.2.1 Description of Utility Metering and Monitoring Systems

Provide in narrative format a description of the utility metering and monitoring systems. Include locations, function, and related systems.

1.7.7.6.2.2 Procedures for Tracking Utility Use and Reporting

Procedures for usage reporting and tracking in support of establishing and monitoring utility budgets and costs, and in developing annual energy reports.

1.7.7.6.2.3 One-Line Diagrams and Meter Location of System

Provide one-line diagrams and design drawings that highlight meter locations on the site.

1.7.7.6.3 Spare Parts and Supply Lists

Provide lists of spare parts and supplies required for repair to ensure continued service or operation without unreasonable delays. Special consideration is required for facilities at remote locations. List spare parts and supplies that have a long lead-time to obtain.

1.7.8 Part 5: Training

Provide a copy of training plans used for each type of equipment along with training materials used, arranged in specification sequence. Provide a copy of training records, sign-in sheets, and agendas. Include training and documentation on the updating and continued use of the O&M Manual.

1.7.9 Part 6: Cx Project Report and TAB Report

Provide the final Cx Plan and complete Cx reports with evaluation and testing forms and records for each building system. Include relevant commissioned system assemblies test reports including installers checklists of assemblies. Provide all Cx Progress Reports, issues and resolutions logs with resolution or status of each item, and a list of any open items and seasonal or additional testing required.

1.7.10 Part 7: Regulatory Requirements

Provide information describing regulatory and policies compliance requirements or provide a reference to where it is stored.

1.7.11 Part 8: Permits

Provide information requiring frequently asked questions and associated answers or provide a reference to where it is stored.

1.7.12 Part 9: Operations and Maintenance Manual Approval

Provide a signed document stating that the project O&M Manual has been reviewed and confirming agreement with the approach it presents. Include contact information for the signer for coordination of any future changes.

1.7.13 Part 10: Risk Category V

For equipment required to be seismically certified according to Sections 23 05 48.19 SEISMIC PROTECTION FOR MECHANICAL SYSTEMS and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT, documentation demonstrating compliance with certification requirements must be maintained in a file identified as "Equipment Seismic Certification Documentation" within the O&M Manual. This file must clearly state: "Replacement or modification of seismically certified components must be approved by a qualified professional engineer according to original certification criteria".

1.8 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

Provide the O&M data packages specified in individual technical sections. O&M Data Packages are one of the components of the O&M Manual. The information required in each type of data package follows:

1.8.1 Package Quality

Documents must be fully legible. Operation and Maintenance data must be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions.

1.8.2 Data Package 1

a. Safety precautions and hazards

b. Cleaning recommendations

c. Maintenance and repair procedures

d. Warranty information

e. Extended warranty information

f. Contractor information

g. Spare parts and supply list

1.8.3 Data Package 2

a. Safety precautions and hazards

b. Normal operations

c. Environmental conditions

d. Lubrication data

e. Preventive maintenance plan, schedule, and procedures

f. Cleaning recommendations

g. Maintenance and repair procedures

h. Removal and replacement instructions

i. Spare parts and supply list

j. Parts identification

k. Warranty information

l. Extended warranty information

m. Contractor information

1.8.4 Data Package 3

a. Safety precautions and hazards

b. Operator prestart

c. Startup, shutdown, and post-shutdown procedures

d. Normal operations

e. Emergency operations

f. Environmental conditions

g. Operating log

h. Lubrication data

i. Preventive maintenance plan, schedule, and procedures

j. Cleaning recommendations

k. Troubleshooting guides and diagnostic techniques

l. Wiring diagrams and control diagrams

m. Maintenance and repair procedures

n. Removal and replacement instructions

o. Spare parts and supply list

p. Product submittal data

q. O&M submittal data

r. Parts identification

s. Warranty information

t. Extended warranty information

u. Testing equipment and special tool information

v. Testing and performance data

w. Contractor information

x. Field test reports

1.8.5 Data Package 4

a. Safety precautions and hazards

b. Operator prestart

c. Startup, shutdown, and post-shutdown procedures

d. Normal operations

e. Emergency operations

f. Operator service requirements

g. Environmental conditions

h. Operating log

i. Lubrication data

j. Preventive maintenance plan, schedule, and procedures

k. Cleaning recommendations

l. Troubleshooting guides and diagnostic techniques

m. Wiring diagrams and control diagrams

n. Repair procedures

o. Removal and replacement instructions

p. Spare parts and supply list

q. Repair work-hours

r. Product submittal data

s. O&M submittal data

t. Parts identification

u. Warranty information

v. Extended warranty information

w. Personnel training requirements

x. Testing equipment and special tool information

y. Testing and performance data

z. Contractor information

aa. Field test reports

1.8.6 Data Package 5

a. Safety precautions and hazards

b. Operator prestart

c. Start-up, shutdown, and post-shutdown procedures

d. Normal operations

e. Environmental conditions

f. Preventive maintenance plan, schedule, and procedures

g. Troubleshooting guides and diagnostic techniques

h. Wiring and control diagrams

i. Maintenance and repair procedures

j. Removal and replacement instructions

k. Spare parts and supply list

l. Product submittal data

m. Manufacturer's instructions

n. O&M submittal data

o. Parts identification

p. Testing equipment and special tool information

q. Warranty information

r. Extended warranty information

s. Testing and performance data

t. Contractor information

u. Field test reports

v. Additional requirements for HVAC control systems

1.8.7 Changes to Submittals

Provide manufacturer-originated changes or revisions to submitted data if a component of an item is so affected subsequent to acceptance of the O&M Data. Submit changes, additions, or revisions required by the Contracting Officer for final acceptance of submitted data within 30 calendar days of

the notification of this change requirement.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 TRAINING

Prior to acceptance of the facility by the Contracting Officer for Beneficial Occupancy, provide comprehensive training for the systems and equipment specified in the technical specifications. The training must be targeted for the building maintenance personnel, and applicable building occupants. Instructors must be well-versed in the particular systems that they are presenting. Address aspects of the Facility Data Workbook and Facility Document Set as defined in 01 78 24.00 10 FACILITY DATA REQUIREMENTS. Training must include classroom or field lectures based on the system operating requirements. The location of classroom training requires approval by the Contracting Officer.

3.1.1 Training Plan

Submit a written training plan to the Contracting Officer for approval at least 60 calendar days prior to the scheduled training. Training plan must be approved by the Commissioning Authority (CxA) prior to forwarding to the Contracting Officer. Also, coordinate the training schedule with the Contracting Officer and CxA. Include within the plan the following elements:

a. Equipment included in training

b. Intended audience

c. Location of training

d. Dates of training

e. Objectives

f. Outline of the information to be presented and subjects covered including description

g. Start and finish times and duration of training on each subject

h. Methods (e.g. classroom lecture, video, site walk-through, actual operational demonstrations, written handouts)

i. Instructor names and instructor qualifications for each subject

j. List of texts and other materials to be furnished by the Contractor that are required to support training

k. Description of proposed software to be used for video recording of training sessions.

3.1.2 Training Content

The core of this training must be based on manufacturer's recommendations

and the operation and maintenance information. The CxA is responsible for overseeing and approving the content and adequacy of the training. Spend 95 percent of the instruction time during the presentation on the OPERATION AND MAINTENANCE DATA. Include the following for each system training presentation:

a. Start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up and programming, troubleshooting, and alarms.

b. Relevant health and safety issues.

c. Discussion of how the feature or system is environmentally responsive. Advise adjustments and optimizing methods for energy conservation.

d. Design intent.

e. Use of O&M Manual Files.

f. Review of control drawings and schematics.

g. Interactions with other systems.

h. Special maintenance and replacement sources.

i. Tenant interaction issues.

3.1.3 Training Outline

Provide the Operation and Maintenance Manual Files (Bookmarked PDF) and a written course outline listing the major and minor topics to be discussed by the instructor on each day of the course to each trainee in the course. Provide the course outline 14 calendar days prior to the training.

3.1.4 Training Video Recording

Record classroom training session(s) on video. Provide to the Contracting Officer two copies of the training session(s) in DVD video recording format. Capture within the recording, in video and audio, the instructors' training presentations including question and answer periods with the attendees. The recording camera(s) must be attended by a person during the recording sessions to assure proper size of exhibits and projections during the recording are visible and readable when viewed as training.

3.1.5 Unresolved Questions from Attendees

If, at the end of the training course, there are questions from attendees that remain unresolved, the instructor must send the answers, in writing, to the Contracting Officer for transmittal to the attendees, and the training video must be modified to include the appropriate clarifications.

3.1.6 Validation of Training Completion

Ensure that each attendee at each training session signs a class roster daily to confirm Government participation in the training. At the completion of training, submit a signed validation letter that includes a sample record of training for reporting what systems were included in the

training, who provided the training, when and where the training was performed, and copies of the signed class rosters. Provide two copies of the validation to the Contracting Officer, and one copy to the Operation and Maintenance Manual Preparer for inclusion into the Manual's documentation.

3.1.7 Quality Control Coordination

Coordinate this training with the CxA in accordance with 01 45 00 QUALITY CONTROL.

3.2 SUBMITTAL SCHEDULING

3.2.1 Operation and Maintenance Manual, Progress Submittal

Submit the Progress submittal when construction is approximately 50 percent complete, to the Contracting Officer for approval. Provide Operation and Maintenance Manual Files (Bookmarked PDF). Include the elements and portions of system construction completed up to this point. The purpose of this submittal is to verify progress is in accordance with contract requirements as discussed during the Operation and Maintenance Manual Coordination Meeting.

3.2.2 Operation and Maintenance Manual, Prefinal Submittal

Submit the 100 percent submittal of the Operation and Maintenance Prefinal Submittal to the Contracting Officer for approval within 90 calendar days of the Beneficial Occupancy Date (BOD). This submittal must provide a complete, working document that can be used to operate and maintain the facility. Any portion of the submittal that is incomplete or inaccurate requires the entire submittal to be returned for correction. Any discrepancies discovered during the Government's review of Operation and Maintenance Progress submittal must be corrected prior to the Prefinal submission. The Prefinal Submittal must include Operation and Maintenance Manual Files (Bookmarked PDF).

3.2.3 Operation and Maintenance Manual, Final Submittal

Submit completed Operation and Maintenance Manual Files (Bookmarked PDF) and one hard copy of the Operation and Maintenance Manuals. The Final submittal is due at BOD. Any discrepancies discovered during the Government's review of the Prefinal submittal, including the Field Verification, must be corrected prior to the Final submission.

-- End of Section --

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SECTION 01 78 23.33

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SECTION 01 78 23.33

OPERATION AND MAINTENANCE MANUALS FOR FUEL SYSTEMS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

U.S. DEFENSE LOGISTICS AGENCY (DLA)

DLA J4 Handbook	(Part IV) Federal Supply Class Assignments (Numeric and Alphabetic Listing) (http://www.dla.mil/)

1.2 CONTRACTOR RESPONSIBILITY

The Contractor is responsible for providing the technical publications specified herein for all of the components, assemblies, sub-assemblies, attachments, and accessories, required to be supplied in accordance with submittal requirements of each specification section, regardless of whether the item was manufactured and assembled in-house or obtained from other sources. The System Supplier is responsible to the Contractor for providing the technical publications specified herein for all of the components, assemblies, sub-assemblies, attachments, and accessories that the System Supplier provided.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-10 Operation and Maintenance Data

System Instructions; G, RO

PART 2 PRODUCTS

2.1 DEVELOPMENT OF SUBMITTALS

2.1.1 Operation and Maintenance System Instructions (OMSI) Submittal Requirements

OMSI submittals are required in order that complete documentation can be assembled to provide the Government "Activity" with the necessary information and orientation to adequately operate and maintain the new structures/facilities of this project. Submit the OMSI documents and information specified for the equipment listed under the OMSI submittal paragraphs in each technical section. Provide copies of each Electronic Operation and Maintenance Support Information (e-OMSI) submittal to the Contracting Officer no later than 120-days prior to contract completion. In addition to requirements of this section, see Section 01 78 23

OPERATION AND MAINTENANCE DATA for additional requirements on assembly of operation and maintenance data. OMSI submittals are to be submitted separate from and in addition to Contractor's product approval submittals.

2.1.2 Assembly

Provide submittals in separate folders consistent with the Contractor's standard practice. For hard copy manufacturer's manuals or data for the components, assemblies, subassemblies, and other operating parts which are provided must be assembled into a loose-leaf notebook-type folder, indexed by major assembly and component in sequential order. Manuals must be complete in all respects for all equipment, controls, and accessories provided. In addition, provide an electronic copy of the manuals in Adobe Acrobat 11.0 or later (CD-ROM or DVD-ROM). Utilize Bookmarks to display indexing, and assembly and component requirements.

2.2 IDENTIFICATION

On each folder identify and mark as follows:

a. Inscribe on the cover, the words, "FUEL SYSTEM OPERATION AND MAINTENANCE MANUAL", the name and location of the building, and the contract number.

b. Equipment manufacturer and/or Contractor's address and telephone number; names, address and telephone numbers of each subcontractor installing equipment; and local representative for each item of equipment.

c. Volume number and title of the folder.

d. The manual must have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. Sub-divide manuals or provide separate manuals for each of the following categories.

(1) Operating Instructions
(2) Maintenance, Service, and Repair Instructions
(3) Parts Manual

PART 3 EXECUTION

3.1 OPERATING INSTRUCTIONS

The operator's instructions must include specific instructions and illustrations of the equipment operation required or recommended by the manufacturer as follows:

3.1.1 Safety

Include manufacturer's safety precautions to be observed while operating under all conditions for which the equipment was designed. Clearly list all major hazards to personnel and equipment safety that are peculiar to systems and equipment described in the manual.

3.1.2 Operator Prestart

Include instructions for prestart checks, lubrication, and service requirements necessary for setting up or preparing each system for use,

warm up procedures, and verification of normal operation. Include control diagrams with data to explain detailed operation and control of each item of the equipment.

3.1.3 Starting and Shutdown Procedures and Controls

Include a control sequence describing start up operation and provide shutdown procedures and post-shutdown requirements.

3.1.4 Normal Operating Instructions

Instructions must be sufficient to enable the mechanic to adjust, stop and start, and operate the equipment properly. Special startup precautions must be noted, as well as other items requiring action before the equipment may be put into service. Include detailed drawings indicating procedure and valve numbers and status as to normally open/closed.

3.1.5 Emergency Operating Procedures

Include action to be taken in the event of a malfunction of the unit, either to permit a short period of continued operation or to prevent further damage to the unit and to the system in which it is installed.

3.1.6 Operator Service Requirements

Include instructions for operator service requirements during operation of the equipment.

3.2 OPERATION INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors who will give full instruction to the designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment or system specified. Each instructor must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work. Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. A minimum of 1 man-day (8-hours) of instruction must be furnished for each system specified in other sections. When more than 4 man-days of instruction are specified, approximately half of the time must be used for classroom instruction. All other time must be used for instruction with the equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, additional instruction must be provided to acquaint the operating personnel with the changes or modifications. Government representatives must be allowed to video tape all classroom and field instructions.

3.3 MAINTENANCE, SERVICE AND REPAIR INSTRUCTIONS

The shop or maintenance manual must include manufacturer's instructions to maintain the equipment in a safe and serviceable condition. The maintenance or shop manual must contain all necessary instructions, illustrations, charges and diagrams covering, as a minimum, the items listed below.

3.3.1 Lubrication Instructions

a. Include a table showing recommended lubricants for specific

temperature ranges and applications.

b. Include chart(s) with schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities. Provide a lubrication schedule showing service interval frequency.

3.3.2 Table of Preventative Maintenance Instructions

Include frequency in time, miles or hours covering routine servicing, lubrication, and adjustments.

3.3.3 Preventative Maintenance Inspection

Points and checklist should be clearly spelled out as part of operator-type inspection in this section. Include chart with schematic diagram and/or a separate inspection checklist indicating what should be examined for wear or possible malfunction and what should be reported for repair.

3.3.4 Troubleshooting Guides and Diagnostic Techniques

Provide step-by-step procedures to enable prompt isolation of the cause of a malfunction with corrective maintenance instructions. Instructions must clearly indicate why the check out is performed and what conditions are to be sought.

3.3.5 Removal and Replacement Instructions

Provide step-by-step procedures for removal, replacement, disassembly and assembly of all components, assemblies, sub-assemblies, accessories, and attachments normally subjected to wear, damage, malfunction, and frequent replacement. These instructions should provide for a judicious combination of text and illustrations.

3.3.6 Maintenance and Repair Procedure

Provide instructions for tolerances, dimensions, settings, and adjustments normally required for performing routine maintenance servicing. Instructions must provide the necessary information to bring equipment up to the required serviceable standard when it becomes unserviceable. Include instructions for examining equipment for needed repairs and adjustment, and any tests or inspections required to determine whether or not parts must be replaced.

3.4 PARTS MANUAL

3.4.1 Contents

The parts manual must provide positive identification and coverage for all of the parts of components, assemblies, sub-assemblies, and accessories of the end item normally subject to wear, malfunctioning, damage, or loss. Include any special hardware requirements (e.g., high-strength bolts and nuts). The parts manual may cover more than one model or series or equipments, components, assemblies, subassemblies, attachments, or accessories, such as a master parts catalog, in accordance with the manufacturer's standard commercial practice. Identification of the parts must be such that all parts may be ordered and centrally stocked by the government without further identification to the make, model, and serial

number of the equipment being provided.

3.4.2 Illustrations, Drawings, and/or Exploded Views

Provide clear and legible illustrations, drawings, and/or views to enable easy identification of all individual parts, components, assemblies, sub-assemblies, and accessories of the end item. Show part numbers and description on illustrations or list separately. When the illustrations omit the part numbers and description, both the illustrations and separate listing must show the index, reference, or key number which will cross-reference the illustrated part to listed part. Parts shown in the listings must be grouped by components, assemblies, and sub-assemblies with individual parts identified to the assembly.

3.4.3 End Item Manufacturer's Part Numbers

Include parts for which the end item manufacturer has proprietary rights or has exercised design control, and for which the end item manufacturer is the logical supplier. The end item manufacturer must also assign numbers to purchased production parts, if such parts are altered to meet the prime manufacturer's design configuration. (Repainting, marking, or other insignificant operations are not adequate cause for use of exclusively assigned numbers).

3.4.4 Components Assemblies/Parts

Include those components assemblies/parts purchased by the end item manufacturer for which the end item manufacturer does not have control, and must be identified by the actual manufacturer's name and part numbers. Detail parts in the manufacturer's assembly, as well as attaching parts, for which the manufacturer does not have design control must also be identified by the applicable actual manufacturer's parts numbers. This paragraph does not restrict the end item manufacturer from assigning part numbers as long as the actual manufacturer's part number and the Federal Supply Code for Manufacturer (DLA J4 Handbook) or manufacturer is shown.

3.4.5 Appendices

End item manufacturer may add an appendix for cross-reference to implement components assemblies/parts requirements when implementation in manual form varies drastically with the style, format, and method of Contractor's standard commercial practice. Subject cross-referenced in an appendix will appear in the following format:

End Item Manufacturer's Alpha Numeric Seq.	Actual Manufacturer's Name and/or FCSM* from DLA J4 Handbook	Actual Manufacturer Part No.
100001	John Doe & Co. 000000	2000002
*Federal Supply Code for Manufacturers Cataloging Handbook, Name to Code		

3.5 VALIDATION

Each submittal must be validated by the Contractor or Manufacturer as being accurate and applicable to the systems and equipment provided.

3.6 SPECIFIC EQUIPMENT SUBMITTALS

The technical sections of this specification identify the specific equipment or systems for which OMSI submittals are required. This paragraph' and its subparagraph contain a general list of various types of equipment and systems together with the OMSI information required for each type. The applicable OMSI information contained in this paragraph must be submitted for each specific piece of equipment or system listed under the "OMSI Submittals" paragraph in the technical sections. Operating instructions; maintenance, service, and repair instructions; and parts manuals must conform to the requirements of their -respective paragraph herein. Provide validation in accordance with paragraph VALIDATION for all submittals.

3.6.1 Pressure Gages

a. Manufacturer's descriptive literature, general.

b. Parts manuals and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

3.6.2 Automatic Pump Controls

Includes Pressure Indicating Transmitters, Flow Switches, Venturi Tubes, Differential Pressure Transmitters.

a. Manufacturer's descriptive literature, general.

b. Parts manual.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Control wiring diagrams showing all terminations of conductors (and all control devices) labeled to permit identification in the field; part numbers of all control devices; normally open or normally closed; voltage of all control components.

h. Name, address and telephone number of the nearest manufacturer's representative.

3.6.3 Meters

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service, calibration instructions, and repair

instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Name, address and telephone number of the nearest manufacturer's representative.

3.6.4 Oil/Water separator and Accessories

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Name, address and telephone number of the nearest manufacturer's representative.

3.6.5 Truck Offload System

a. General description and specifications.

b. Comprehensive discussion of operating program.

c. Installation and initial checkout procedures.

d. Detailed electrical description.

e. Complete troubleshooting procedures, diagrams, and guidelines.

f. Complete alignment and calibration procedures for components.

g. Preventive maintenance requirements.

h. Detailed system schematics, system field assembly drawings, and system component specifications and dimensions.

i. Complete spare parts lists.

j. Complete as-built bill of materials, control drawings, schedules, and sequence of operations.

k. Safety precautions.

l. Control sequence describing start-up, operation, and shutdown. Control sequence must be integrated with startup and operation of the motor control center.

m. Provide part list that clearly indicates sources of supply, recommended spare parts, and name of servicing organization.

n. Manufacturer's name, address, and telephone number.

3.6.6 Piping and Fittings

a. Certificates of Compliance.

b. Batch run numbers.

c. Manufacturer's descriptive literature, general.

d. Name address and telephone number of manufacturer.

3.6.7 Manual Valves

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Where specified to have limit switches, control wiring diagrams showing all terminations of conductors (and all control devices) labeled to permit identification in the field; part numbers of all control devices; normally open or normally closed; voltage of all control components.

h. Name, address and telephone number of the nearest manufacturer's representative.

3.6.8 Gaskets and Isolating Gasket Kits

a. Manufacturer's descriptive literature, general.

b. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

c. Name, address and telephone number of the nearest manufacturer's representative.

3.6.9 Strainers

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Manufacturer's name, model number, serial number, Federal Stock Number

(if any).

e. Name, address and telephone number of the nearest manufacturer's representative.

3.6.10 Protective Coatings

a. Manufacturer's descriptive literature, general.

b. Maintenance, service and repair instructions.

c. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

d. Name, address and telephone number of the nearest manufacturer's representative.

e. Product standards compliance and the materials system data sheet.

3.6.11 Sample Connections

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Name, address and telephone number of the nearest manufacturer's representative.

3.6.12 Filter Separators

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Operating Instructions.

e. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

f. Performance data at specified conditions.

g. Name, address and telephone number of the nearest manufacturer's representative.

3.6.13 Pumps

a. Manufacturer's descriptive literature, general.

b. Parts manual and recommended spare parts list.

c. Maintenance, service and repair instructions.

d. Manufacturer's name, model number, serial number, Federal Stock Number (if any).

e. Performance data at specified flow rates. Performance must include:

(1) Head developed, horsepower required and efficiency.

(2) Pump curves, flow and power requirements, efficiency, head and operating speed. Curves to show operating points at full range of operating conditions.

f. Control wiring diagrams showing all terminations of conductors (and all control devices) labeled to permit identification in the field; part numbers of all control devices; normally open or normally closed; voltage of all control components and operational description.

g. Plan and elevation views of equipment showing clearance required for maintenance and/or replacement.

h. Name, address and telephone number of the nearest manufacturer's representative.

i. Shipping and operating weights.

j. Operating instructions.

k. Factory run test curves indicating flow, head rpm, vibration amplitude and BHP.

3.6.14 Flexible Hoses

a. Manufacturer's descriptive literature, general.

b. Maintenance service and repair instructions.

c. Manufacturer's name, model number, serial number.

d. Name, address and telephone number of the nearest manufacturer's representative.

3.6.15 Control Valves

Submit for each type control valve specified

a. Manufacturer's descriptive literature, general.

b. Operational description of valve and control pilots.

c. Description of valve assembly complete with parts list.

d. Recommended spare parts list for main valve and pilot control systems.

e. Instructions for trouble shooting.

f. Maintenance, service and repair instructions.

g. Manufacturer's name, model number and stock number.

h. Operational Test Data.

3.6.16 Engine-Generator

a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the system or equipment.

b. A control sequence describing startup', operation, and shutdown.

c. Description of the function of each principal item of equipment.

d. Installation and maintenance instructions.

e. Safety precautions.

f. Diagrams and illustrations.

g. Testing methods.

h. Performance data.

i. Lubrication schedule including type, grade, temperature range, and frequency.

j. Parts list: Provide list that clearly indicates sources of supply, recommended spare parts, and name of servicing organization.

k. List qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

3.6.17 Motor Control Center

a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the system or equipment.

b. A control sequence describing startup, operation, and shutdown.

c. Description of the function of each principal item of equipment.

d. Installation and maintenance instructions.

e. Safety precautions.

f. Diagrams and illustrations.

g. Parts list.

h. Drawing of component arrangement, schedule of components with sizes, types, and ratings.

i. Manufacturer's name, model number, serial number.

j. Name, address and telephone number of the nearest manufacturer's representative.

3.6.18 Pump Control Panel (PCP)

a. General description and specifications.

b. Comprehensive discussion of both hardware and operating program.

c. Installation and initial checkout procedures.

d. Detailed electrical and logical description.

e. Complete troubleshooting procedures, diagrams, and guidelines.

f. Complete alignment and calibration procedures for components.

g. Preventive maintenance requirements.

h. Detailed system schematics, system field assembly drawings, and system component specifications and dimensions.

i. Complete spare parts lists.

j. Interface requirements and capabilities.

k. Signal identification and timing diagrams.

l. Complete as-built bill of materials, control drawings, schedules, and sequence of operations.

m. Safety precautions.

n. Control sequence describing start-up, operation, and shutdown. Control sequence must be integrated with startup and operation of the motor control center.

o. Provide part list that clearly indicates sources of supply, recommended spare parts, and name of servicing organization.

p. Manufacturer's name, address, and telephone number.

q. Supplier name, manufacturer and version of all software including: PLC, desktop computer, laptop computer, and "alternate" desktop computer.

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FACILITY DATA REQUIREMENTS

05/23

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FACILITY DATA REQUIREMENTS
05/23

PART 1 GENERAL

This specification requires the collection, organization, and turnover of electronic Facility Data for specific assets designed and constructed as part of this contract. Provide a Facility Document Set (FDS) and Facility Data Workbook (FDW) as defined in this specification. See Sections 01 33 00 SUBMITTAL PROCEDURES, 01 78 39.00 24 AS-BUILT DRAWINGS, and 01 78 23 OPERATION AND MAINTENANCE DATA, for additional Facility Data delivery requirements.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 19005-3	(2012) Document Management -- Electronic Document File Format for Long-Term Preservation -- Part 3: Use of ISO 32000-1 with Support for Embedded Files (PDF/A-3)
ISO 32000-1	(2008) Document Management -- Portable Document Format -- Part 1: PDF 1.7

1.2 DEFINITIONS AND ABBREVIATIONS

1.2.1 Assets

Assets are specific items of property or equipment.

1.2.2 Attributes

Attributes are individual pieces of Facility Data that describe facilities and their associated assets.

1.2.3 Facility Data

Information defined and collected in the Facility Data Workbook (FDW) and Facility Document Set (FDS).

1.2.4 Facility Document Set (FDS)

An electronically compiled and organized document containing the supporting documents and data used to populate the Facility Data Workbook during its respective phase of development.

a. For construction-based deliverables, the FDS is comprised of the project Operation and Maintenance Data Packages and Government-Approved Record drawings.

1.2.5 Facility Data Workbook (FDW)

A pre-formatted spreadsheet template used to compile Asset, Attribute, Facility, and Space Data that the Government wishes to manage via electronic means. The FDW also contains all requirements associated with proper collection, organization, and turnover of the Facility Data.

1.2.6 Facility Data Project Execution Plan (FDPxP)

A document that describes the clear and organized plan for the collection, organization, and turnover of the Facility Data deliverables required by this specification. The Contractor may consolidate BIM PxP requirements defined in 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS and FDPxP requirements defined herein and integrate them into a single, consolidated BIM/Facility Data PxP for Government approval.

1.3 UNITS OF MEASURE

Provide Facility Data deliverables utilizing the units of measure identified in the contract documents.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" or "S" classification are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Facility Data Project Execution Plan(FDPxP); G, DO

SD-10 Operation and Maintenance Data

Facility Data Workbook, Construction Progress; G, RO

Facility Document Set, Construction Progress; G, RO

SD-11 Closeout Submittals

Facility Data Workbook, Construction Final; G, RO

Facility Document Set, Construction Final; G, RO

1.5 QUALITY CONTROL

1.5.1 Facility Data Project Execution Plan (FDPxP)

Provide the Government with a plan for the collection, organization, and turnover of the Facility Data deliverables to the Government. At a minimum, include the following items in the FDPxP:

1.5.1.1 Front Matter

Provide a Cover Page, Table of Contents, and Executive Summary/Objectives.

1.5.1.2 Project Information

List the Project Owner, Project Name, Project Location and address, Contract Type, Project Description, Project/Contract Number, Project Milestones.

1.5.1.3 Submittal Schedule

Identify delivery schedule for all deliverables in compliance with the submission requirements identified in this specification.

1.5.1.4 Personnel

Identify key personnel involved in the development of the Facility Data deliverables including Contractor and Government personnel.

1.5.1.5 Facility Data Workbook(s)

Identify Facility and Space Data as applicable at time of FDPxP submission. Individually list every asset group from the FDW Requirements that will require Facility Data collection. No attribute data is required at this time. Identify asset groups from the FDW Requirements that are not required within the scope of this Contract. Document the version of FDW to be used through the duration of the project.

1.5.1.6 Facility Document Set(s)

Define structure and format of the submittal. Provide a comprehensive outline of the final FDS to be delivered. Organize the outline with headings, titles, and descriptions such that the Government may ascertain that working documents comply with the formatting requirements defined by this specification.

1.5.1.7 Protocols

Detailed procedures:

a. Facility Data documentation/collection process.

b. Facility Document Set production/development process.

c. Collaboration procedures including strategy, meetings, communication, and subcontractor/consultant involvement.

d. Quality Control, including site verification of FDW, as applicable.

e. File and folder naming structure.

f. Hardware and software being used for collection and organization of Facility Data. Identify type, format, and anticipated organization of digital storage media to be provided as part of required deliverables. Include means and methods for checking deliverables for malicious content.

1.5.2 Meetings

To assure that Facility Data requirements are being met through the duration of the project, organize the following meetings and discuss the subsequent topics:

1.5.2.1 Pre-Construction Meeting

At a minimum, discuss the following:

a. The requirement for Facility Data deliverables under this contract.

b. Primary roles and responsibilities associated with the development and delivery of the Facility Data deliverables, and.

c. Identify and agree upon a date and attendance list for the meetings described below:

1.5.2.2 FDPxP Coordination Meeting

a. Facilitate a meeting following submission and Government review of the FDPxP. Include the Facility Data Preparer(s), Quality Control (QC) Manager, Commissioning Authority (CA), Government's Facility Data Proponent, Contracting Officer's Representative, and Base Civil Engineer (BCE) Facilities Management Specialist (FMS).

b. The purpose of this meeting is to coordinate the efforts necessary by contract parties to ensure an accurate collection, preparation, quality control, and submittal of these deliverables.

c. The FDPxP serves as the primary agenda for this meeting. At a minimum, discuss the following:

(1) Processes and methods of gathering facility data during construction. Discuss and obtain special permissions and waivers as necessary (such as photo waivers and data encryption);

(2) Contractor Quality Control practices and procedures;

(3) Corrective actions necessary for Government approval of FDPxP;

(4) Necessity for additional or recurring Facility Data Coordination Meetings outside of those required by this specification, as requested by the Contractor. Intent of these meetings would be to maintain regular contact between responsible parties of the Contractor and Government with regard to development of the facility data deliverables. Conduct status meetings with a frequency agreed upon at this meeting.

1.5.2.3 Submittal Coordination Meeting

a. Facilitate a meeting following submission and Government review of each design or progress submittal of the Facility Data. Include the Facility Data Preparer(s), Designer of Record (DOR), Quality Control (QC) Manager, Commissioning Authority (CA), Government's Facility Data Proponent, Contracting Officer's Representative, and Base Civil Engineer (BCE) Facilities Management Specialist (FMS). Include Mechanical, Electrical, Plumbing, and Fire Protection subcontractors as applicable.

b. The purpose of this meeting is to demonstrate ongoing compliance with the requirements identified in this specification.

c. The applicable deliverables, along with Government remarks associated with review of these submittals serve as the primary guide and agenda

for this meeting. At a minimum, discuss the following during this meeting:

(1) Review assets, applicable attributes, facility, and space data in FDW at time of submittal;

(2) Demonstrate Quality Control and site verification procedures, as applicable, by Contractor QC;

(3) Review contents and organization of FDS at time of submittal;

(4) Discuss Government review comments and unresolved items preventing completion and Government approval of the Facility Data Workbook and Facility Document Set.

1.5.3 Facility Turnover and Contract Closeout

Include the Facility Document Set, Construction Final as a deliverable in Facility Turnover and Contract Closeout procedures as defined in 01 78 39.00 24 AS-BUILT DRAWINGS.

1.5.4 Facility Data Workbook Quality Requirements

For each submittal, ensure that the information contained in the FDW(s) reflects the minimum content requirements defined in the PART 3 EXECUTION portion of this section. Ensure that information provided as part of the FDW(s) conforms to the standards described below:

a. Compile FDW(s) using approved spreadsheet templates. Do not alter the formatting or organizational layout of the templates. For this Contract, templates are available for download from the USACE CAD/BIM Technology Center website, site information provided in the PART 2 PRODUCTS portion of this section.

b. Instructions for the proper maintenance and completion of these FDWs are contained in the FDW Requirements contained within the FDW template.

1.5.5 Facility Document Set Quality Requirements

Ensure that information provided as part of each FDS conforms to the electronic and data formatting standards identified below:

1.5.5.1 Document Files

Utilize PDF file format in accordance with ISO 32000-1 and ISO 19005-3 for all document-based files. Provide files from original sources, text-searchable, and saved in "Standard" (uncompressed) resolution. Bookmark and label files as defined in the PART 2 PRODUCTS portion of this section.

1.5.5.2 Photograph Files

If photographs are required, utilize JPEG file format for all photograph and image files. Provide full-color photos with photo resolution of not less than 4 megapixels and not more than 12 megapixels.

Provide a copy of installation-specific letters or waivers allowing permission to take installed equipment photographs on this Contract.

Waivers need not be attached to every photo, only one copy of each permission letter need be included in the Government deliverables.

1.5.5.3 Drawing Files

Provide all drawings required by this specification in full-size PDF format in accordance with ISO 32000-1 and ISO 19005-3. Produce PDF files from original sources, text-searchable, and saved in "Standard" (uncompressed) resolution whenever possible. Bookmark and label files as defined in the PART 2 PRODUCTS portion of this section.

Submission of scanned or photocopied drawing files is prohibited. Only vector-preserved PDF files are acceptable.

1.5.6 Facility Document Set Integrity Requirements

Ensure that information provided as part of each FDS conforms to the integrity standards identified below:

1.5.6.1 File Protection

Do not restrict data files, document files or photographic files from being printed, exported, modified or copied. Do not deliver files with restrictions such as expiration date and locks for access, viewing, archiving, or editing.

1.5.6.2 Manufacturer-Specific Documents

Provide text-searchable, vector-based document files from the manufacturer's online or electronic documentation. Color documents are preferred. Provide documents specific to the product(s) installed under this Contract. When possible, do not submit document files containing multiple product catalogs from the same manufacturer, or product data from multiple manufacturers in the same file. Provide documents directly from the manufacturer whenever possible. Do not provide scanned copies of hardcopy documents.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver facility data submittals in an organized and legible manner. Provide submittals adhering to the requirements of described below.

1.6.1 Number of Copies

Provide three identical copies of disks for approval; for each submittal and each facility required. Provide on approved electronic media (one copy per disk or set of disks) as defined below. Provide submittal files on electronic storage media in compliance with the quality requirements identified in this specification.

1.6.2 Malicious Content

Scan all files for malicious viruses using a commercially available scanning program that is routinely updated to identify and remove current virus threats.

1.6.3 Storage Media

Provide facility data on disk-based (DVD-R/RW) media. Deviations from the

required storage media must be approved by the Government. Select and apply technology used for electronic data transmission to ensure that the full Facility Data submittal for each facility is provided on one single disk, whenever possible. When separation of the submittal is required, first separate the FDS and the FDW onto separate media. Second, separate FDS into logical segments or components. Further divisions must be documented in the FDPxP and approved by the Government.

Provide Facility Data on disk-based (DVD-R/RW) media. Deviations from the required storage media must be approved by the Government. Select and apply technology used for electronic data transmission to ensure that the full Facility Data submittal for each facility is provided on one single disk, whenever possible. When separation of the submittal is required, first separate the FDS and the FDW onto separate media. Second, separate FDS into logical segments or components. Further divisions must be documented in the FDPxP and approved by the Government.

a. Apply a label directly printed to storage media. Do not provide adhesive, paper-based labels. List the name of the facility, Project, Project location, Contract number, Designer of Record firm/Prime Contractor company's name, title of submission, and security classification (in accordance with the appropriate security classification labeling regulations) on the label. If multiple disks are provided, clearly document the contents of each disk on the label.

b. Include the name and contact information of the individual who produced the final data disk to ensure that problems with the data or media can be easily resolved.

c. When browsed on a computer, the disk must display the following folders and their associated content:

(1) Facility Data Workbook (containing 1 FDW per facility);
(2) Facility Document Set (containing 1 FDS per facility);
(3) FDPxP (containing 1 PxP per contract);
(4) Readme (Containing 1 TXT, PDF, or HTML file with general use information, organizational instructions, and basic preparer contact information. Include all information included on the storage media label).

PART 2 PRODUCTS

2.1 FACILITIES

Facilities that require individual (separate and complete) Facility Data deliverables as described in this specification are as follows:

a. (Coordinate Project Title(s) with Contracting Officer after Construction Contract Award)

2.2 FACILITY DATA WORKBOOK(S)

Provide one compiled FDW for each facility identified above. Complete all portions of each FDW including facility, space, asset, and attribute data in compliance with the FDW Requirements. Download the current FDW template (.xlsm format) from the USACE CAD/BIM Technology Center website at https://cadbimcenter.erdc.dren.mil.

2.2.1 Spaces

Provide data for all applicable spaces in the facility. Minimum space definitions are as follows:

a. Provide all rooms as defined in the design documents.
b. If not otherwise defined, provide a minimum of one "roof" space in the FDW.
c. If not otherwise defined, provide a minimum of one "site" space in the FDW.
d. Provide all spaces not otherwise described, but necessary to accurately indicate the location of all FDW assets required by this specification.

2.2.2 Assets

a. Compile an FDW that contains the maintainable and warrantable equipment (assets) associated with each facility. This includes assets in contract scope and within the project extents. See 01 78 39.00 24 AS-BUILT DRAWINGS and 01 78 23 OPERATION AND MAINTENANCE DATA for related requirements. Assets include, but are not limited to, those types described in the "Required Assets" portion of the FDW template, those assets listed in the table below, and additional assets defined in the FDPxP. Itemized FDW asset entries (instance-based). Entries indicative of multiple assets (type-based) are not allowed.

b. Compile an FDW that contains the maintainable and warrantable equipment (assets) associated with each facility. This includes assets in contract scope and within the project extents. See 01 78 39.00 24 AS-BUILT DRAWINGS and 01 78 23 OPERATION AND MAINTENANCE DATA for related requirements. Assets include, but are not limited to, those types described in the "Required Assets" portion of the FDW template, those assets listed in the table below, and additional assets defined in the FDPxP. Itemized FDW asset entries (instance-based). Entries indicative of multiple assets (type-based) are not allowed.

SUPPLEMENTAL ASSET LIST (INCLUDE IN ADDITION TO "REQUIRED ASSETS" LISTED IN FDW TEMPLATE)	
Asset	Description/Example
Fixtures, Furnishings, and Equipment	Furniture, systems furniture, appliances, and other significant items of equipment
Valves	All operable valves in facility including but limited to those installed in plumbing, HVAC, fuel distribution, and fire protection systems.
Tanks and Vaults	Items such as expansion tanks, septic tanks, oil-water separators, grease separators, diesel bulk/operating/day tanks
Material Handling Equipment	Items such as cranes, equipment lifts, fuel distribution pumps

SUPPLEMENTAL ASSET LIST (INCLUDE IN ADDITION TO "REQUIRED ASSETS" LISTED IN FDW TEMPLATE)	
Control Equipment	Panels and consoles associated with the facility automation and control systems integration.

Document assets applicable to the scope of this project in the FDPxP.

c. Sub-component assets that are an integral and functional part of another component (e.g. An electric motor that serves as part of an air-handling unit) need not be duplicated or listed separately as its own asset.

d. Definitions, descriptions, and formatting requirements for these assets can be found in the FDW Requirements contained within the FDW template.

e. If an asset type is not included in the scope of the Project, no Facility Data (assets or attributes) are to be included in the FDW (even as a placeholder) for that asset type.

2.2.3 Attributes

a. Populate each individual asset with all required attributes defined in the "Required Attributes" portion of the FDW template.

b. Definitions, descriptions, and formatting requirements for these attributes can be found in the FDW Requirements contained within the FDW template.

c. If an attribute is not applicable, populate that field with "N/A." Do not leave it blank.

2.3 FACILITY DOCUMENT SET

2.3.1 Organization

Organize the FDS in a hierarchical manner as follows. Use electronic bookmarks to create an easily navigable document. The first and primary hierarchical level must contain the following bookmarks:

a. "O&M Data" - See subordinate hierarchical requirements in the "O&M DATA HIERARCHY" paragraph.

b. "Record Drawings" - See subordinate hierarchical requirements in paragraph RECORD DRAWINGS HIERARCHY.

2.3.1.1 O&M Data Hierarchy

Under "O&M Data" provide all Government-Approved O&M Data Packages as defined in 01 78 23 OPERATION AND MAINTENANCE DATA and as required by technical specifications contained within this contract. Further organize this information under the following hierarchical levels:

a. The contract specification and title under which the Data Package and the associated equipment or system references. (e.g. 26 23 00 - LOW-VOLTAGE SWITCHGEAR)

b. The Data Package Number as defined in 01 78 23 OPERATION AND

MAINTENANCE DATA. (e.g. Data Package 2)

2.3.1.2 Record Drawings Hierarchy

Under "Record Drawings" provide an electronic copy of the Government-Approved record drawings, as specified in 01 78 39.00 24 AS-BUILT DRAWINGS, for the project in PDF format. Further group discipline sheets under the following hierarchical levels:

a. The full discipline heading represented by the contents of the sheet and as shown in the Record Drawing Sheet Index. Organize these headings in the order that the drawings set is organized. (General, Civil, Structural, Architectural, Interiors, Plumbing, Mechanical, Electrical, Telecommunications, etc.)

b. The Sheet ID and Sheet Name as found in the Record Drawing Sheet Index and in accordance with the AEC CAD Standard referenced in 01 78 39.00 24 AS-BUILT DRAWINGS. (e.g. G-001 - LEGEND; CS101 - SITE PLAN AREA 101; A-101 - OVERALL FIRST FLOOR PLAN; P-601 - FIRST FLOOR DWS WATER RISER DIAGRAM, etc.)

PART 3 EXECUTION

3.1 CONSTRUCTION PROGRESS SUBMITTALS

Submit the FDW and FDS construction progress submittals together. Meet the following completeness and formatting requirements listed below:

a. Provide Facility Data Workbook, Construction Progress submittal(s) when all assets are identified, but not later than 90 days prior to Beneficial Occupancy Date (BOD) as identified in the Government-Approved construction schedule. Clearly identify assets or asset groups missing in the "variations" section of the ENG Form 4025 Transmittal Form provided with the submittal. Populate assets with front-loaded attribute data that is available at the time of asset input. See the FDW Requirements contained within the FDW template for a list of attributes to be completed for this submittal.

b. Submit individual FDW templates for each facility identified in the "FACILITIES" paragraph. While FDWs are not required to be complete for this submittal, provide accurate and correctly formatted data according to the FDW Requirements.

c. Submit a sample or working Facility Document Set, Construction Progress submittal containing "draft" or "example" documents that are organized in the manner defined by this specification. Draft or example documents need not be technically accurate or complete in their content, but defined and separated in a manner such that all organizational and formatting requirements defined by this specification may be evaluated.

3.2 CONSTRUCTION FINAL SUBMITTALS

Submit the FDW and FDS construction final submittals as they are completed. Coordinate the Facility Data Workbook, Construction Final submittal with data verification procedures as defined in the accepted FDPxP. Provide the Facility Document Set, Construction Final submittal only after Government acceptance of its individual components as defined by 01 78 39. 00 24 AS-BUILT DRAWINGS and 01 78 23 OPERATION AND MAINTENANCE DATA.

3.3 FACILITY DATA WORKBOOK VERIFICATION

Verify the FDW through the quality control personnel and procedures as defined in the FDPxP. Coordinate and conduct verification with commissioning procedures defined in 01 91 00.15 TOTAL BUILDING COMISSIONING.

One-hundred percent accuracy of FDW information is required for Government acceptance of the Facility Data Workbook, Construction Final submittal.

--Attachments--
Project Facility Data Worksheets

-- End of Section --

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SECTION 01 78 36.00 24

WARRANTY OF CONSTRUCTION

4/07

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SECTION 01 78 36.00 24

WARRANTY OF CONSTRUCTION
4/07

PART 1 GENERAL

1.1 WARRANTY OF CONSTRUCTION

(a) Foremost and in addition to any other warranties in this contract, the Contractor warrants, except as provided in paragraph (i) of this clause, that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, design furnished, or workmanship performed by the Contractor or any subcontractor or supplier at any tier.

(b) This warranty shall continue for a period of 1 year from the date of final acceptance of the work. If the Government takes possession of any part of the work before final acceptance, this warranty shall continue for a period of 1 year from the date the Government takes possession.

(c) The Contractor shall remedy at the Contractor's expense any failure to conform, or any defect. In addition, the Contractor shall remedy at the Contractor's expense any damage to Government-owned or controlled real or personal property, when that damage is the result of--

(1) The Contractor's failure to conform to contract requirements; or

(2) Any defect of equipment, material, workmanship, or design furnished by the Contractor.

(d) The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause.

(e) The Contractor's warranty with respect to work restored, repaired or replaced will run for 1 year from the date of restoration, repair or replacement. This provision applies equally to all items restored, repaired, or replaced under paragraph (c) and (d) above.

(f) The Government will notify the Contractor, in writing, within a reasonable time after the discovery of any failure, defect, or damage. Repair work necessary to correct a warranty condition which arises to threaten the health or safety of personnel, the physical safety of property or equipment, or which impairs operations, habitability of living spaces, etc., will be performed by the Contractor on an immediate basis as directed verbally by the Government. Written verification will follow verbal instruction.

(g) If the Contractor fails to remedy any failure, defect, or damage within a reasonable time after receipt of verbal or written notice, the Government shall have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.

(h) With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall--

(1) Obtain all warranties that would be given in normal commercial practice;

(2) Require all warranties to be executed, in writing, for the benefit of the Government, if directed by the Contracting Officer; and

(3) Enforce all warranties for the benefit of the Government, if directed by the Contracting Officer.

(i) In the event the Contractor's warranty under paragraph (b) of this clause has expired, the Government may bring suit at its expense to enforce a subcontractor's, manufacturer's, or supplier's warranty.

(j) Unless a defect is caused by the negligence of the Contractor or subcontractor or supplier at any tier, the Contractor shall not be liable for the repair of any defects of material or design furnished by the Government nor for the repair of any damage that results from any defect in Government-furnished material or design.

(k) This warranty shall not limit the Government's rights under the Inspection and Acceptance clause of this contract with respect to latent defects, gross mistakes, or fraud.

(l) The Prime Contractor shall designate a representative to attend and chair warranty meetings that will be held each month at the project site for the duration of the warranty period, with government and subcontractor personnel as necessary. The meeting shall review past warranty corrections and response times, open warranty items, up-coming scheduled corrections, site investigations, and other issues.

1.2 ADDITIONAL WARRANTY REQUIREMENTS

1.2.1 Performance Bond

(a) It is understood that the Contractor's Performance Bond will remain effective for one (1) year from the date of acceptance.

(b) If either the Contractor or his representative doesn't diligently pursue warranty work to completion, the contractor and surety will be liable for all costs. The Government, at its option, will either have the work performed by others or require the surety to have it done. Both direct and administrative costs will be reimbursable to the Government.

1.2.2 Pre-Warranty Conference

(a) Prior to contract completion and at a time designated by the Contracting Officer or his authorized representative, the Contractor shall meet with the Contracting Officer or his authorized representative to develop a mutual understanding with respect to the requirements of the Paragraph: WARRANTY OF CONSTRUCTION. Communication procedures for Contractor notification of warranty defects, priorities with respect to the type of defect and other

details deemed necessary by the Contracting Officer or his authorized representative for the execution of the construction warranty shall be established/reviewed at this meeting.

(b) In connection with these requirements and at the time of the Contractor's quality control completion inspection, the Contractor will furnish the name, telephone number and address of the service representative which is authorized to initiate and pursue warranty work action on behalf of the Contractor and surety. This single point of contact will be located within the local service area of the warranted construction, will be continuously available, and will be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any Contractual responsibilities in connection with the paragraph: WARRANTY OF CONSTRUCTION.

(c) Local service area is defined as the area in which the contractor or his representative can meet the response times as described in paragraph 1.2.4 and in any event shall not exceed 200 miles radius of the construction site.

1.2.3 Equipment Warranty Identification

The Contractor shall provide warranty identification tags on all mechanical and electrical equipment installed under this contract. Tags and installation shall be in accordance with the requirements of Paragraph: EQUIPMENT WARRANTY IDENTIFICATION TAGS.

1.2.4 Warranty Service Calls

The Contractor or his local service representative will respond to the site, to a call within the time periods as follows: Four (4) hours for Heating, Air Conditioning, Refrigeration, Air Supply and Distribution, Critical Electrical service Systems and Food Service Equipment and Twenty-Four (24) hours For All Other Systems.

1.2.5 Equipment Warranty Booklet

At or before 30 days prior to final inspection and acceptance of the work, the Contractor shall submit the data mentioned as follows:

The Contractor shall provided a Booklet, which consists of a listing of all equipment items (see paragraphs a. and b. below) which are specified to be guaranteed along with the warranty papers for each piece of equipment. Three (3) legible bound copies of the booklet shall be submitted for approval and shall be indexed alphabetically by equipment type. For each specific guaranteed item, the name, address, and telephone number shall be shown on the list for the subcontractor who installed equipment, equipment supplier or distributor, and equipment manufacturer. Completion date of the guarantee period shall correspond to the applicable specification requirements for each guaranteed item. The names of service representatives that will make warranty calls along with the day, night, weekend and holiday contacts for response to a call within the time period specified shall also be identified.

a. For Equipment in Place: The equipment list shall show unit retail value and nameplate data including model number, size, manufacturer, etc. This would include capital equipment and other nonexpendable supplies of a movable nature that are not affixed as an integral part of the facility

and may be removed without destroying or reducing the usefulness of the facility. Some examples are spare parts, special tools, manufacturing equipment, maintenance equipment, instruments, installed under this contract.

b. For Installed Building Equipment: The equipment list shall show unit retail value and nameplate data including model number, size, manufacturer, etc. This would include items of equipment and furnishings (including material for installation thereof), which are required to make the facility usable and are affixed as a permanent part of the structure. Some examples are plumbing fixtures, laboratory counters and cabinets, kitchen equipment, mechanical equipment, electrical equipment, and fire protection systems installed under this contract.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-11 Closeout Submittals

Equipment Warranty Booklet

1.4 EQUIPMENT WARRANTY IDENTIFICATIONS TAGS

1.4.1 GENERAL REQUIREMENTS

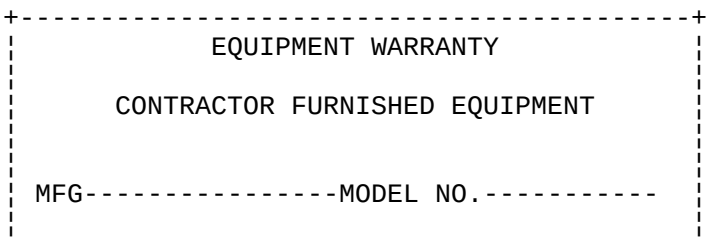
The Contractor shall provide warranty identification tags on all Contractor and government furnished equipment which is Contractor installed.

1.4.1.1 Tags and Information

The tags and information shall be similar in format and size to the exhibits provided by this specification, and shall be suitable for interior and exterior locations, resistant to solvents, abrasion, and to fading caused by sunlight, precipitation, etc. These tags shall have a permanent pressure- sensitive adhesive back, and shall be installed in a position that is easily (or most easily) noticeable. If the equipment surface is not suitable for adhesive back, Contractor shall submit his alternative to the Contracting Officer's Authorized Representative for review and approval. Contractor furnished equipment that has differing warranties on its components will have each component tagged.

1.4.1.2 Tags for Warranted Equipment

The tag for his equipment shall be similar to the following:



| SERIAL NO.---------- |
| CONTRACT NO.---------- |
| CONTRACTOR NAME---------- |
| CONTRACTOR ADDRESS---------- |
| CONTRACTOR TELEPHONE---------- |
| CONTRACTOR WARRANTY EXPIRES---------- |
| IN CASE OF WARRANTY ACTION FIRST CONTACT |
| (DEH) (BCE) AT (TELEPHONE NUMBER) |

| EQUIPMENT WARRANTY |
| GOVERNMENT FURNISHED EQUIPMENT |
| MFG _____ MODEL NO._____ |
| SERIAL NO. _____ |
| CONTRACT NO. _____ |
| DATE EQUIP PLACED IN SERVICE _____ |

1.4.1.3 Exclusion to Providing Tags

If the manufacturer's name (MFG), model number and serial number are on the manufacturer's equipment data plate and this data plate is easily found and fully legible, this information need not be duplicated on the equipment warranty tag. The Contractor's warranty expiration date and the final manufacturer's warranty expiration date will be determined as specified by the Paragraph "WARRANTY OF CONSTRUCTION".

1.4.2 EXECUTION

The Contractor will complete the required information on each tag and install these tags on the equipment by the time of and as a condition of final acceptance of the equipment. The Contractor shall be responsible for scheduling acceptance inspection with the Contracting Officer (verbal and written notification required). If this inspection is delayed by the Contractor, the Contractor shall, at his own expense, update the in-service and warranty expiration dates on these tags.

1.4.3 Equipment Warranty Tag Replacement

Under the terms of this contract, the Contractor's warranty with respect to work repaired or replaced shall run for one year from the date of repair or replacement. Such activity shall include a data warranty

identification tag on the repaired or replaced equipment. The tag shall be furnished and installed by the Contractor, and shall be similar to the original tag, except that it should include the scope of repair and that the contractor's warranty expiration date will be one year from the date of acceptance of the repair or replacement. In the case of repair, the repair only will be covered by the extended warranty. In the case of replacement of a component, the component only will be covered by the extended warranty. In these cases, the original tags will not be removed, but an additional tag will be installed for the repair or component replacement.

PART 2 NOT USED

PART 3 NOT USED

-- End of Section --

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SECTION 01 78 39.00 24

AS-BUILT DRAWINGS
02/22

PART 1 GENERAL

Attachments: Modifications and Title Block Examples

1.1 DEFINITIONS

The definitions listed below form a part of this specification.

1.1.1 Red-Line Drawings

Contract drawings marked-up during construction to show actual work performed to include necessary sketches, modification drawings, shop drawings and notes.

1.1.2 As-Built Drawings

Professionally-finished bond paper drawings and Electronic CAD Files developed from the contract drawings that include all of the information from the redline drawings and suitable for half-size reproduction. Building Information Modeling (BIM) files are considered a part of As-Built Drawings. See Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS for additional requirements and deliverables.

1.1.3 Black-Line Drawings

Paper drawings reproduced from electronic CAD files or high quality reproducible drawings.

1.1.4 Full-Size Drawings

22 inches x 34 inches nominal size drawings with all details visually readable so that half-size plot will fit on 11 inches x 17 inches cut sheets.

1.1.5 Modification Circle

A circle with a horizontal line through the center to identify modification changes on the drawings. The top half will contain the letter "R" with the bottom half containing the Modification number, unless directed otherwise. The lettering standard will be 1/8-inch Arial.ttf.

1.1.6 Electronic CAD Files

See Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS.

1.1.7 Building Information Modeling (BIM) Files

See Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS for definition.

1.2 REFERENCES

U.S. ARMY CORPS OF ENGINEERS (USACE)

ERDC/ITL TR-19-7	(2019) A/E/C CAD Standard - Release 6.1
EM 1110-1-2909	(2012) Geospatial Data and Systems

1.3 SUSTAINABILITY REQUIREMENTS

Materials in this technical specification may contribute towards contract compliance with sustainability requirements. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for project requirements.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

50 Percent Preliminary As-Built Drawings; G, RO

100 Percent Preliminary As-Built Drawings; G, RO

SD-11 Closeout Submittals

Final As-Built Drawings; G, RO

Sustainability Documentation; G, RO

1.5 GENERAL REQUIREMENTS

1.5.1 As-built Drawings

Upon award of this contract, the Government will provide the Contractor PDFs of the Contract drawings. Once the Contractor makes hardcopy distribution of these drawings in accordance with Section 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS, the Government will provide the Contractor with Govenment-furnished electronic CAD Files and BIM Files in the formats indicated in Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS.

Maintain electronic CAD files, BIM files and Red-Line Drawings showing As-Built conditions. Provide as-built Building BIM model in compliance with USACE Minimum Modeling Matrix (M3) for Level of Detail (LOD) and element Grade for "Record Models" as referenced in Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS. Use the ERDC/ITL TR-19-7 USACE A/E/C CAD Standard for the As-Built drawings. Obtain the A/E/C Standards in effect at time of Contract Award. The A/E/C Standards are available at:

https://cadbimcenter.erdc.dren.mil/

(New users will be required to register. See "New User Registration" at

the website indicated above.)

Obtain the required CAD software and BIM software for Contractor use. **Do not convert electronic drawing files from one software language to another unless as specifically allowed or required in Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS.** Show the transmittal requirements for the As-built Drawings as activities on the Contractor-prepared project schedule.

Show all changes from the contract drawings on the as-builts. Accurately and neatly record all changes on the As-built drawings using the same symbols, terminology, and general quality as the original set of contract drawings. Show all changes on all drawings that are affected by the change. Changes include: actual work performed, deviations resulting from Government responses to Requests for Information or Serial letters, surveys, shop drawings, descriptive changes, sketch changes, and modifications to the contract. Show all systems designed or enhanced by the Contractor such as HVAC control system, fire alarm system fire sprinkler system, and irrigation sprinkler system, on the As-built drawings. Where contract drawings or specifications allow for options, only show the option selected and actually constructed on the As-Built Drawings.

1.5.2 Red-Line Drawings

Update Red-Line Drawings throughout the construction phase of the contract showing all changes that will be shown on the final as-builts. Place all as-built conditions on the Red-Line Drawings **within two (2) days** after completing the work activity or it shall be entered on the deficiency tracking system (see Section 01 45 00 QUALITY CONTROL). The Government will consider the Contractor to not be making satisfactory progress and will withhold funds from progress payments if the Contractor does not completely and accurately update the as-built drawings.

Provide red-line drawings in an electronic format.

1.5.2.1 Electronic Red-Lines

Make electronic red-line drawings available to the COR at all times through a Local Area Network (LAN) or Internet connection. The connection shall have a download transfer rate not less than 10 Megabit/second (~1.250 Megabytes/second) and an upload transfer rate of not less than 1 Megabit/second (~124 kilobytes/second) in order to facilitate the timely access of drawing files. Make backups of all the electronic drawings at the close of business on the final day of work each week on a durable digital media such as removable hard-drive, tape drive, or optical disk. Preserve each weekly file system backup over the course of the project and do not overwrite; label the file folders or individual media with the date of backup. Store the weekly backup media in a fireproof and waterproof safe in a locked room of the Contractor's trailer. Electronically provide the COR with updated PDF drawings on a monthly basis. Show all changes to the electronic drawings with clouding and in accordance with ERDC/ITL TR-19-7.

1.5.3 GeoDataBase

Provide digital media containing a SDSFIE/FGDC GeoReferenced personal GeoDataBase, in accordance with the requirements of this section and EM 1110-1-2909, unless otherwise directed by the Contracting Officer.

See Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS for applicable references and requirements.

1.5.4 Sustainability Documentation

Sumbit all Sustainability documentation that was submitted in the USGBC templates and any other documentation which supports the templates and indicates compliance with related Federal Mandates once Sustainability Documentation is finalized. See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for detailed requirements. Submit all Sustainability documentation within 120 days after the final inspection. Place the Sustainability documentation on one DVD and send to the COR.

1.6 PAYMENT

In accordance with FAR 52.232-5 "Payment Under Fixed - Price Construction Contracts", the Contracting Officer may withhold up to 10 percent of payment until the Contractor delivers to the COR and the COR accepts the Final As-Built Drawings and GeoDatabase Files. The amount withheld will be equal to the cost-loaded close-out activity "Submission and approval of as-built drawings" per Section 01 32 01.00 10 PROJECT SCHEDULE.

1.7 CONTRACTOR PERFORMANCE RATING

The Government will evaluate the Contractor's performance in CPARS (Contractor Performance Assessment Reporting System) at intervals of no more than 365 days during the period of performance and complete the final evaluation within 120 days of completion of the project. The timeliness and quality of As-Built drawings submittals, Final As-built Drawings, Red-line drawings, Sustainability Documentation, and GeoDataBase Files will be an important factor in determining the assigned rating for the Schedule evaluation area. If the Contractor fails to submit complete and accurate Final As-Built Drawings and GeoDataBase Files within sixty (60) calendar days of turning the completed project over to the Using Service, this failure will be noted in the comments under the Schedule evaluation area and may result in a lower rating for this area. Repeated failure to submit correct and accurate As-Built drawings submittals, Final As-built Drawings, Red-line drawings, Sustainability Documentation, and GeoDataBase Files may also result in lower ratings for the Quality and Management evaluation areas. The Contractor shall receive an Unsatisfactory rating for Sustainability documentation if Sustainability documentation is not submitted within 120 days after the final inspection.

1.8 TRANSMITTAL OF AS-BUILT DRAWINGS

Send the as-built submittals listed below to the Omaha District Office at the following address:

ATTN: Patricia Lambert (CENWO-CDS-C)
U.S. Army Corps of Engineers
Omaha District
1616 Capitol Ave
Omaha, NE 68102-4901

1.8.1 Optional As-built Drawings Sample

Optionally submit a sample of preliminary as-built drawings to the Omaha District Office that will be reviewed for formatting purposes. Include

five distinct sheets from the project drawings in this submittal. Send this optional submittal on approved digitial media to the Omaha District Office and include the following:

a. Electronic CAD/BIM/CIM Files
b. Individual PDF Drawings
c. One (1) Combined Set of full-size PDF Drawings with bookmarks for each sheet

1.8.2 50 Percent Preliminary As-Built Drawings

Submit the 50 Percent Preliminary As-Built Drawings to the Omaha District Office within ten (10) days after 50% physical completion unless otherwise directed by the COR. The Government will review these drawings for technical content and formatting requirements. Include all changes up to the time of submission with "clouding" around the changes on the electronic CAD Files. Submit all drawings contained in the complete project set of drawings plus any additional drawings with the 50 Percent Preliminary As-Built Drawings. Include the following on the approved digital media for the 50 Percent Preliminary As-Built Drawings:

a. All documents and files required under "Advanced Modeling Submittal Packaging" paragraph of Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS.
b. Current electronic red-line drawings for reviewing purposes.

If a resubmittal is required, resubmit within fifteen days after receiving comments back from the Government. Failure to submit the 50 Percent Preliminary As-Built Drawings by the specified time will result in the Government not considering the Contractor to be making satisfactory progress on the project and witholding funds from the progress payments.

1.8.3 100 Percent Preliminary As-Built Drawings

Submit the 100 Percent Preliminary As-Built Drawings including all changes to the drawings as specified to the Omaha District Office. The 100 Percent Preliminary As-Built Drawings will be reviewed for technical content and formatting requirements. Within thirty (30) days after the final inspection, submit 100 Percent Preliminary As-Built Drawings indicating all as-built changes with "clouding" on all of the project drawings. Submit all drawings contained in the complete project set of drawings plus any additional drawings with the 100 Percent Preliminary As-Built Drawings. The COR may grant the Contractor additional time if the Contractor is making reasonable progress on the as-builts, in the sole judgment of the COR. Do not submit the Final As-Built Drawings until the 100 Percent Preliminary As-Built Drawings are approved. Include the following on the approved digital media for the 100 Percent Preliminary As-Built Drawings:

a. All documents and files required under "Advanced Modeling Submittal Packaging" paragraph of Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS.
b. Current electronic red-line drawings for reviewing purposes.

Also include one hardcopy set of half-size black-line drawings on bond paper.

1.8.4 Final As-Built Drawings

Produce Final As-Built Drawings without "clouding". Include all changes shown on the 100 Percent Preliminary As-Built Drawings plus any additional required changes on the Final As-Built Drawings. Submit all drawings contained in the complete project set of drawings plus any additional drawings with the Final As-Built Drawings. Submit the Final Drawings no later than ten days after the 100 Percent Preliminary As-Built Drawing submittal is approved. The COR may grant additional time if the Contractor is making reasonable progress on the as-builts. Send the following to the COR:

Three approved digital media containing the following:

a. All documents and files required under "Advanced Modeling Submittal Packaging" paragraph of Section 01 33 39.00 10 ADVANCED MODELING (BIM/CIM/GIS/CAD) REQUIREMENTS.
b. Current electronic red-line drawings for reviewing purposes.

Include one hardcopy set of half-size black-line drawings on bond paper in documents sent to COR.

Send one copy of the digital media only to the Omaha District Office.

1.9 AS-BUILT DRAWINGS FORMAT REQUIREMENTS

1.9.1 General Formatting

Prepare As-built Drawings in accordance with ERDC/ITL TR-19-7 requirements and/or match the detail shown on the contract drawings. Include all of the requirements below on the drawings:

a. Update the drawing index when drawings are added.
b. When opened, ensure the view is zoomed to fit the border.
c. Reference a border supplied by the CAD/BIM Technology Center (https://cadbimcenter.erdc.dren.mil/) placed in the layout/sheet model at a scale of 1 at the location (0,0) in all files.
d. Delete all unnecessary information outside the border.
e. Purge/compress all files.
f. Include all reference files in appropriate folders within the provided workspace.
g. Use the Arial.ttf font for all text.
h. Provide an ASCII text file with the following information: the name and phone number of the person we need to contact if we have problems, and the version of the CAD software used to create and/or work on the drawings.
i. (CAD only) Supply pen tables for plotting.
j. (CAD only) Provide each sheet/design with its own file and file name with only one layout/sheet per design file.
k. (CAD only) Accomplish half toning by using the color 8 and setting the pen table to plot color 8 to half tone.
l. The file name is the project code followed by the sheet identification number. Include the file name in the border on every sheet and match the name of the file on the Digital Media. The project code is BUCO00102.
m. The file number in the border is no longer used.
n. Change the cover sheet from "Contract Award Set" to "As-Built Record Set" with month & year completed.
o. Show drawing changes by "clouding" the affected area in layer

"G-ANNO-REVS" (CAD only) in the drawing file of all preliminary as-builts and redlines. For BIM, accomplish clouding commensurate with the available tools.
p. Place all submitted Electronic CAD Files and PDF drawings under a folder labeled "As-Built" on the submitted Digital Media.
q. Include the name of the project, location, project code, solicitation number, contract number, and words detailing which submittal it is on both the Digital Media case and Digital Media. Title the Final As-builts Drawings "As-Built Record Set".
r. Do not use zipped or compressed folders on any of the As-built submittals.
s. On the cover sheet add or revise text to read "This folio includes all reissued and descriptive amendments, RFIs, and modifications."
t. Place the Electronic CAD native design files and PDF drawings in separate folders on the Digital Media.

1.9.2 Title Block

Fill in and correct all information in the title block. Include all the requirements below in the title block.

a. Add "RECORD DRAWING" text below the title block on the right side of the drawing on all sheets.
b. Add the date in the revision box for modifications from Block 3 of Form SF-30.
c. State "REVISED TO SHOW AS-BUILT CONDITIONS" and date the top line of the revision box. Use a "-" for the "Mark".
d. Enter the month and year as-builts were completed in the date box.
e. Show the contract number and the solicitation number (if available) on all sheets.
f. Properly identify additional word abbreviations, not found on the abbreviation sheet but necessary to describe the work, and incorporate with the other standard word abbreviations.
g. Properly note modifications in the title block in accordance with paragraph "Modification Changes" below.

1.9.3 Modification Changes

Include all modification changes on the as-built drawings. At a minimum, include all revised and reissued sheets, descriptive changes, sketches, etc. Change other sheets as appropriate with any modification change that also affects other sheets other than the one referenced with the modification. Typically, modification changes can be done by following the descriptive change included with the modification, but may require additional effort depending on the change and level of detail of the modification change. Post modifications in accordance with the following:

a. Follow directions in the modification for posting all changes.
b. Post all modifications to the contract in chronological order.
c. Show the last modification number completed on the sheet with the modification circle in the top right corner of the "Project Title" and "Project Location" box.
d. Place a modification number in the revision box over column entitled "Mark" for all modifications to plans, sections, or details. Use the statement "GENERAL REVISIONS" when applicable.
e. Make the Modification Circle size 1/2-inch diameter unless the area where the circle is located is crowded. Use a smaller size circle for crowded areas.
f. Place a Modification Circle at the location of each deletion.

g. For all new details or sections that are added to a drawing, place a Modification Circle by the detail or section title.
h. For changes to a drawing, place a Modification Circle by the title of the affected plan, section or detail titles (each location).
i. For changes to schedules on drawings, place a Modification Circle either by the schedule heading or by the change in the schedule.

1.9.4 Legends

Do not use symbols which conflict with those on the original contract legend sheet. Properly identify and add to the legend sheet or supplemental legend additional symbols necessary to depict any additional work items. Those projects that do not have legend sheets may use supplemental legends on each sheet where symbol is shown.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 GENERAL

Make revisions to and maintain the red-line and as-built drawings to the same level of detail as shown on the original contract drawings. Provide any additional drawings as required to display all details. In addition, prepare the GeoDatabase Files as specified above and submit in conjunction with the As-Built drawings.

3.2 SITE WORK

3.2.1 Utilities

Show all utilities whether active or abandoned on the as-built drawings and include all those shown on the original contract drawings or found on-site. Show the type of utility, location, general direction, size, material make-up and depth. Show the location and description of any utility line or other installations of any kind known to exist within the construction area. Include dimensions to permanent features as part of the location. Locate during installation all new underground utility lines (including electrical power and communications, gas, water, sanitary sewer, storm drains, roof drains and culverts). Survey pipe invert of gas, water, sanitary sewer, storm drains, roof drains and culverts and top of duct bank of electrical power and communications lines and associated fixtures (valves, manholes, test points, meters, cathodic protection points, tanks, ground points, and all point features along the new utility lines). Survey storm drains and sanitary sewer lines where pipes enter manholes and inlets and at 100-foot maximum intervals along the line. Survey the inverts of all cleanouts and tees. Survey inverts at each end of culverts. Survey electrical power, communications, gas and water lines at all manholes, tees, valves, corners, changes in direction and at intervals along the line to accurately depict the location of the line in both horizontal and vertical directions (50-foot maximum interval). Make the horizontal and vertical accuracy such that 100% of the points are + 0.25' of their absolute position.

3.2.2 Structures

Show structures above and below ground. Show the size, material make-up, location, height, and/or depth. Show rim elevation and invert elevations as applicable at manholes. Show electrical equipment, guy wires, and

voltage rating on power poles.

3.2.3 Grades

Correct grade or alignment of roads, structures, or utilities if any changes were made from the contract drawings. Correct elevations if changes were made in site grading. If any grades were finalized outside of the respective grades tolerances, show that new grade on the as-builts.

3.3 STRUCTURAL

3.3.1 Steel/Concrete

Incorporate shop drawings that deviate from the contract drawings in the As-Built Drawings.

3.4 MECHANICAL

3.4.1 Ductwork

Show ductwork to reflect actual installation and duct size. Show ductwork routing changes.

3.4.2 Plumbing

Show piping and fixtures to reflect the type of material, size and the route or location.

3.5 ELECTRICAL

3.5.1 PANELS

Revise all contract drawing panel schedules to show as-built conditions. Ensure home-run circuit designation on electrical drawingsaccurately correspond to the as-built panel schedules.

3.5.2 Controls

Revise all control diagrams in contract drawings to reflect as-built conditions and setpoints.

3.6 CONTRACTOR SHOP DRAWINGS

Incorporate contractor shop drawings, which supersede data on the contract plans and/or additional drawings, prepared by the Contractor, into the As-Built Drawings. Include the designer's name on the As-Built Drawings for any design plans prepared by the Contractor.

-- End of Section --

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RECORD DRAWING

REVISION DESCRIPTIONS - FOR AMENDMENTS AND/OR MODIFICATIONS:

CHG #000X - CHANGE ORDER	(DESCRIPTION & REASON FOR CHANGE ARE THE SAME AS AMENDMENTS LISTED BELOW)
AM #000X - GENERAL REVISION - NEW DRAWING	(DRAWING THAT WAS NOT ORIGINALLY INCLUDED IN THE ADVERTISED SET)
AM #000X - GENERAL REVISION	(THIS WOULD BE FOR ANY RE-ISSUED DRAWINGS, TYPICAL CHANGES OR CORRECTIONS)
REVISED IN ACCORDANCE WITH AM #000X	(THIS IS FOR DESCRIPTIVE CHANGES THAT WENT OUT IN THE AMENDMENT - DRAWING IS NOT RE-ISSUED - AND THE CHANGES ARE THEN LATER POSTED TO THE DRAWINGS AS IT BECOMES A CONTRACT SET)
— (DASH) REVISED TO SHOW AS-BUILT CONDITIONS	

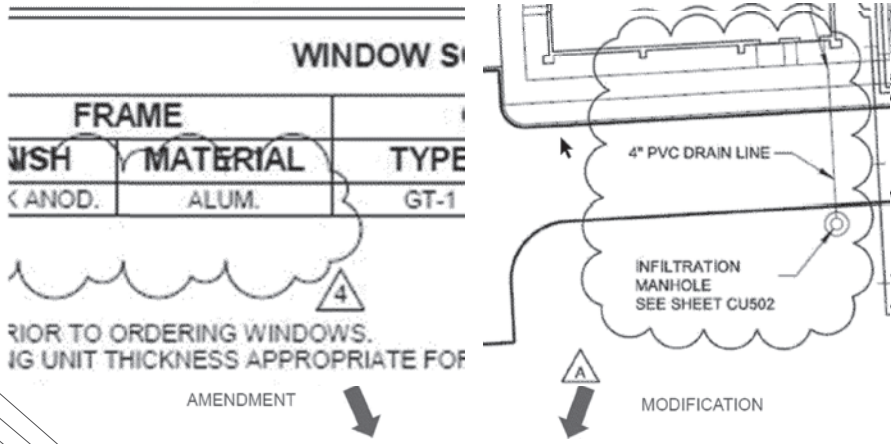
DEFINITIONS OF REVISIONS:

1. LAST ENTRY IN DESCRIPTION BOX SHALL APPLY TO AS-BUILT CONDITIONS
2. REVISIONS BY MODIFICATIONS (AFTER AWARD FOR AS-BUILT CONDITIONS)
3. METHOD OF ADDING NEW DRAWING BY MODIFICATION.
4. REVISIONS BY MODIFICATION. (AFTER AWARD OF CONSTRUCTION CONTRACT).
5. METHOD OF ADDING NEW DRAWING BY AMENDMENT.
6. METHOD OF ADDING NEW DRAWING BY CHANGE ORDER.
7. REVISIONS BY AMENDMENT WHEN DRAWING IS TO BE RE-ISSUED.
8. REVISIONS BY CHANGE ORDER WHEN DRAWING IS TO BE RE-ISSUED.

INSTRUCTIONS FOR NOTING REVISIONS:

1. ADD THE REVISION DESCRIPTION (EITHER CHANGE ORDER, AMENDMENT OR MODIFICATION DESCRIPTION AS APPLICABLE).
2. ADD THE PROPER REVISION MARK NUMBER / LETTER TO THE LEFT OF THE REVISION NOTATION.
3. ADD THE PROPER AM OR MOD SYMBOL NEAR EACH REVISED ITEM IN THE BODY OF THE DRAWING.
4. WHEN ADDING A NEW DRAWING TO SHOW SUPPLEMENTAL DATA, USE SAME DRAWING NUMBERS AS DRAWING WITH SIMILAR SUBJECT MATTER AND ADD AN ALPHABETICAL SUFFIX TO THE SHEET NO. THIS DRAWING SHOULD BE ADDED TO THE INDEX OF DRAWINGS IN ITS PROPER PLACE ACCORDING TO THE SHEET NUMBER.

DRAWING ANNOTATION



NOTES:
- AMENDMENT / CHANGE ORDER **'MARK'** IS CONSECUTIVE NUMBERS AND WILL NOT NECESSARY BE THE SAME AS THE AM / CHG NUMBER.
- CHANGE ORDERS ARE ONLY USED FOR TASK ORDERS TO **MATOC** PROJECTS. AN INDIVIDUAL PROJECT WILL EITHER HAVE AMENDMENTS OR CHANGE ORDERS NOT BOTH.
- MODIFICATION **'MARK'** IS CONSECUTIVE LETTERS AND WILL NOT BE THE SAME AS THE MOD NUMBER.
- AM / CHG AND MOD NUMBERS ARE OBTAINED BY THE PROJECT MANAGER.

SHEET ID

PROJECT/CONTRACT LOCATION 1
PROJECT/CONTRACT DESCRIPTION 2

SHEET TITLE 1
SHEET TITLE 2
SHEET TITLE 3

U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE.
OMAHA, NE 68102

DESIGNED BY: J. DESIGNER	ISSUE DATE: MMMMMMMMM YYYY
DRAWN BY: J. DRAWER	SOLICITATION NO.: XXXXXX-XX-X-XXXX
CHECKED BY: J. CHECKER	CONTRACT NO.: XXXXXX-XX-X-XXXX
SUBMITTED BY: J. SUBMITTER	FILE NUMBER: %OPTIONAL VALUE 1%
SIZE: ANSI D	FILE NAME: %OPTIONAL VALUE 2%

MARK	DESCRIPTION	DATE
-	REVISED TO SHOW AS-BUILT CONDITIONS	05-22-2025
C	MOD #0012 - GENERAL REVISIONS	09-22-2024
B	MOD #0006 - NEW DRAWING ADDED	09-14-2024
A	MOD #0003 - GENERAL REVISIONS	09-03-2024
3	AM #0005 - NEW DRAWING ADDED	08-18-2024
2	CHG #0004 - NEW DRAWING ADDED	07-03-2024
1	AM #0001 - GENERAL REVISIONS	06-28-2024
1	CHG #0001 - GENERAL REVISIONS	06-15-2024

US Army Corps of Engineers®

SHEET 1 of 2

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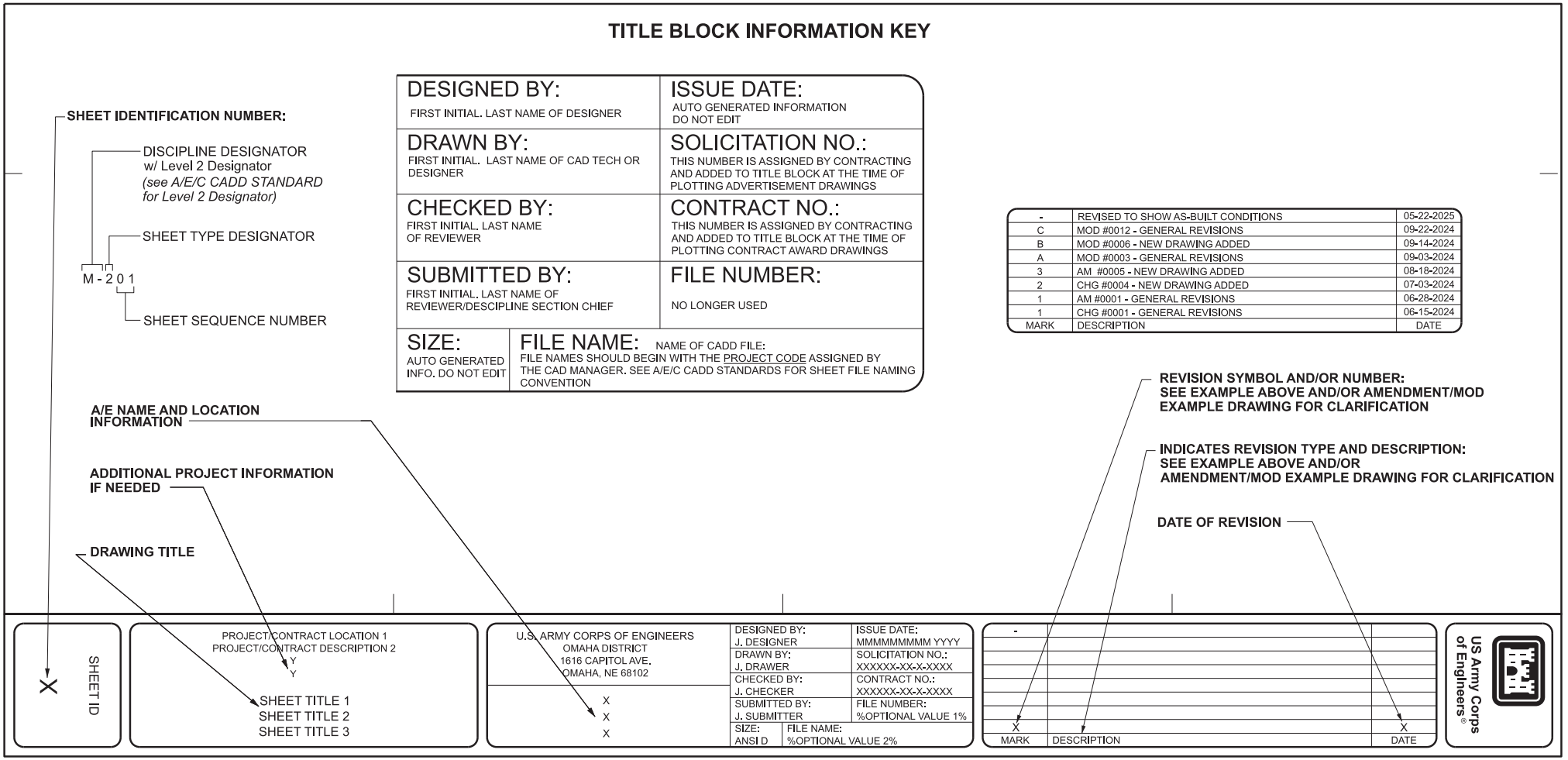
NWO CAD MANAGER 08/15/2024 MICROSTATION

TITLE BLOCK INFORMATION KEY



RECORD DRAWING

SHEET 2 of 2

\\nwofpcadd01\wrkcadd\oddg\OddgAmendMod-2024.dgn

CAD, Drawings, Asbuilt, and Survey Standard

Contract Resource

Buckley AFB - 460th CES - GeoBase

Version 1.0

AS-BUILTS
As-built will be provided in both CAD and PDF formats and submitted to the GeoBase office either electronically using DoD SAFE or burned to a disc and delivered. The PDF will be one file and include a complete set of As-Built files. The PDF will include bookmarks referencing the sheet number and discipline. The PDF will have the following naming convention: YYYYMMDD Project Title. The file date will match the date of the signed as-built.

DRAWINGS/STANDARDS
Drawings shall be submitted as an independent drawing set in accordance with the current version of the CAD/BIM Technology Center for facilities, infrastructure, and environment A/E/C CAD Standard and CAD Drafting Standard. A/E/C CAD Standard Annotation levels/layers shall be set to AutoCAD Index Color #7. (e.g. A-ANNO-TEXT). The file name of each CAD file will match Project name, sheet number and discipline.

Decimal units shall be used for all exterior drawings (site plans, utilities, etc.) more than five (5) feet from the affected facility, or projects that do not affect a building and shall coincide with installation data features. Architectural units shall be used for all interior drawings.

The sheet file shall form the basis for all plotting and exporting functions. Relative paths shall be used for all model file references attached to a sheet set file. Each Layout in a sheet file shall be discipline specific with each discipline's layers visible without manipulation by the user upon opening and be "ready-to-plot". Title blocks and cover sheets developed by the Contractor or provided by the Government shall be present in the AutoCAD Layout (Paper Space) for all sheet files submitted (or model file Layouts for single drawing submissions). Minimum information included in the title block will have the contract number, project number, project title, sheet name, discipline, drawing number, and date.

A cover sheet with an index will be provided. The index will contain the sheet numbers and sheet page. Sheets should be organized by and named by discipline.

SURVEY DATA
Project surveys shall be at an accuracy level of +/-.02 feet. All projects shall clearly indicate survey site control Basis of Bearings statement with the control monuments used to establish that control.

REFERENCE DATUM. As-Built, CAD files, or Survey data shall be horizontally referenced to NAD 83 State Plane Colorado FIPS 0502 Central U.S. Feet Coordinate System and vertical coordinates shall be based on the North American Vertical Datum of 1988 (NAVD 88). Reference datum and coordinates systems used shall be clearly identified. (Reference: the Geospatial Positioning Accuracy Standards, Part 4; Standards for Architecture, Engineering, Construction (A/E/C), Facility Management (FGDC-STD-007.4-2002)) and ECB 2016-24 Engineering and Construction Bulletin.

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05/23, CHG 3: 08/24

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SECTION 01 91 00.15

BUILDING COMMISSIONING
05/23, CHG 3: 08/24

PART 1 GENERAL

Building Commissioning is a systematic, quality-focused process for enhancing the delivery of a project that focuses on verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, configured, operated, and maintained to meet the project requirements. The purpose is to reduce the cost and performance risks associated with delivering facilities projects, and to increase value to owners, occupants, and users. Refer to specification sections 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS variants. Cybersecurity hardening of various facility related control systems (FRCS) will be done as an integral part of the commissioning process to ensure that all FRCS are fully functional while hardening is accomplished to maximum extent.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 180	(2018) Standard Practice for Inspection and Maintenance of Commercial Building HVAC Systems
ASHRAE 202	(2018) Commissioning Process for Buildings and Systems

ASSOCIATED AIR BALANCE COUNCIL (AABC)

ACG Commissioning Guideline	(2005) Commissioning Guideline

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB S1110	(2019) Whole Building Technical Commissioning of New Construction; 2nd Edition

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

ANSI/SMACNA 014	(2013) HVAC Systems Commissioning Manual, 2nd Edition

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 25-345-1 (2019) Commissioning -- Systems Manual

1.2 DEFINITIONS

Commissioning Process (Cx) - a quality-focused process for enhancing the delivery of a project. Refer to ASHRAE 202 for a comprehensive description of the commissioning process.

Lead Commissioning Specialist (CxC) - The entity who leads, plans, and coordinates the Commissioning Team. The terms Commissioning Provider, Commissioning Firm, Lead Commissioning Specialist, Commissioning Specialist, and Commissioning Authority (CA or CxA) when used by sustainable Third Party Certification (TPC) programs, are interchangeable.

Commissioning Authority – The Government retains the authority for oversight and assurance of the entire commissioning process, and final approval of all commissioning deliverables.

1.3 COMMUNICATION WITH THE GOVERNMENT

The Lead Commissioning Specialist (CxC) must submit all plans, schedules, reports, and documentation directly to the Contracting Officer's Representative concurrent with submission to the Quality Control (QC) Manager.

The Lead Commissioning Specialist must have direct communication with the Contracting Officer's Representative regarding all elements of the commissioning process; however, the Government has no direct contract authority with the Lead Commissioning Specialist.

1.4 SYSTEMS TO BE COMMISSIONED

All planning, design, and construction of FRCS or Operational Technology (OT) for existing and new facilities including integration into existing control systems shall be done in accordance with the requirements set forth. Coordinate commissioning and quality control activities for systems, equipment, and associated controls, and commission in accordance with this section, and the inspection, testing, and quality control requirements of the respective related specification sections. Refer to System-specific requirements, which are located in the related specification sections. Several of the FRCS require commissioning by AHJ's other than the Commissioning Team. Coordinate with all AHJ's to ensure systems are fully commissioned while hardened for cybersecurity requirements.The following is a non-comprehensive list of systems to be commissioned:

Fire Protection Life-Safety Systems which include Fire Alarm Reporting System (FA), Fire Suppression System, Mass Notification System (MN)

Building (Level) Automation System (BAS) which includes Heating, Ventilation and Air Conditioning Systems (HVAC), and refridgeration systems (mechanical and passive), service hot-water systems, water pressure-booster systems, and associated controls

Energy Monitoring and Control System (EMCS) and Utility Monitoring and Control System (UMCS)

Fuel Control Systems

Lighting systems: interior and exterior, occupancy sensing devices, automatic shut-off controls, time switching, and other lighting control devices, etc.

Cranes

Variable Frequency Drives

Impressed-Current Cathodic Protection Systems

Electrical Distribution System (Exterior and Interior) with micrologic processors

Generator, Digital Master Controller, Automated Switchgear, Automatic Transfer Switch

Utility Metering System (Advanced Meters, AMI,Water, etc.)

Public Address System (PA)

Other FRCS as defined by Project Requirements, and not specifically identified. Any system, or component of a system, which has wireless, radio frequency (rf), bluetooth, network communication capabilities, or a port for connecting a laptop/computer, or has programmable configuration features.

1.5 RELATED SECTIONS

Refer to the following technical sections for additional commissioning requirements for respective systems:

23 08 00 COMMISSIONING OF MECHANICAL AND PLUMBING SYSTEMS

Variants of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS (Ex: 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC)

26 08 00 APPARATUS INSPECTION AND TESTING

26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES

33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT)

1.6 COMMISSIONING TEAM

The Commissioning team will include, but is not limited to the following team members.

Ensure all Construction Activities for systems to be commissioned are coordinated with the appropriate commissioning team members.

a. Lead Commissioning Specialist (CxC)

b. QC Manager

c. Sub-Contractor Representatives for each trade responsible for

construction/installation of systems to be commissioned

d. Contractor's Project Manager

e. Technical Commissioning Specialists for each system to be commissioned

f. TAB Representative

g. Equipment manufacturer representatives

h. Government Contracting Officer

i. Government Representatives

j. Installation Maintenance Representative

k. Facility End User

l. Cybersecurity Subject Matter Expert(s) (SME's)

m. Designer of Record (DOR)

1.7 PROJECT SCHEDULE

Include the following tasks in the project schedule required by Section 01 32 01.00 10 PROJECT SCHEDULE. Ensure sufficient time is scheduled to complete each item. The order of items listed below is not intended to imply a specified sequence:

a. Submission and approval of the Commissioning Firm Qualifications

c. Submission and approval of the Design Review Report

d. Submission and approval of the Interim and Final Construction Phase Commissioning Plans

e. Commissioning Kickoff Meeting

f. Regular Commissioning Coordination Meetings

g. Installation of permanent utilities (gas, water, electric, steam)

h. Manufacturer's Equipment Start-Up for each of the systems to be commissioned

i. Submission and approval of the Completed Commissioning Observation Checklists

j. Submission and approval of Certificate of Readiness for each system to be commissioned

k. Commissioning Testing, including Functional Performance Testing, for each system to be commissioned

l. Integrated Systems Tests

m. Post-test deficiency correction for each system to be commissioned

n. Re-Testing

o. Submission and approval of the Maintenance and Service Life Plans

p. Submission and approval of the Systems Manual

q. Training for each of the systems to be commissioned

t. Submission and approval of the Final Commissioning Reports

1.8 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Completed Construction Observation Checklists; G, RO

Design Review Report; G, DO

Interim Construction Phase Commissioning Plan; G, RO

Final Construction Phase Commissioning Plan; G, RO; S

Issues Log; G, DO

SD-07 Certificates

Commissioning Firm; G, RO

Certificate of Readiness; G, RO

SD-10 Operation and Maintenance Data

Maintenance and Service Life Plan; G, RO

Systems Manual; G, RO

SD-11 Closeout Submittals

Final Commissioning Report; G, RO

Updated Final Commissioning Report; G, RO

1.9 COMMISSIONING FIRM

Employ the services of a Commissioning Firm and all Commissioning Specialists required to perform work for this project. The Commissioning Firm must be a first-tier subcontractor that is financially and corporately independent from prime contractor and all other subcontractors and the Designer of Record and that is not participating in any other work on this Contract, including design, furnishing equipment, construction, or testing, adjusting, and balancing.

a. Submit the Commissioning Firm's and Commissioning Specialists' qualifications, including the name of the firm and each CxC and each certification, no later than 60 calendar days after notice to proceed.

b. If, for any reason, a specialist loses a certification during this period, immediately notify the Contracting Officer and submit another Commissioning Specialist for approval. An approved successor must validate all work performed for this project by the CxC who lost a certification.

1.9.1 Commissioning Specialists (CxC)

Assign Lead Commissioning Specialist and other appropriate Commissioning Specialists for the systems to be commissioned.

1.9.1.1 Lead Commissioning Specialist (CxC)

Lead Commissioning Specialist (CxC) coordinates all aspects of the commissioning process. Duties include leading and overseeing the commissioning work and acting as the primary point of contact for the commissioning work. CxC may serve as a systems Specialist if all requirements for both designations are met. CxC must have a minimum of five years of commissioning experience, including two projects of similar size and complexity to this project.

CxC must be certified in one of the following:

NEBB Building System Commissioning Professional (CxCP)

ACG Certified Commissioning Authority (CxA)

ICB/TABB Certified Commissioning Supervisor

BCA Certified Commissioning Professional (CCP)

AEE Certified Building Commissioning Professional (CBCP)

University of Wisconsin-Madison Qualified Commissioning Process Provider (QCxP)

ASHRAE Building Commissioning Professional (BCxP).

1.9.1.2 Commissioning Specialists

Refer to the related technical commissioning specification section for additional qualifications for each Commissioning Specialist associated with each system. Include all Commissioning Specialist qualifications with the Commissioning Firm submittal:

a. Mechanical Commissioning Specialist: The technical work associated with mechanical systems to be commissioned must be performed by a Commissioning Specialist certified by NEBB, ACG, ICB/TABB, AEE, University of Wisconsin-Madison, ASHRAE, or BCA in the commissioning of HVAC systems with five years of experience in the commissioning of HVAC systems.

b. Electrical Commissioning Specialist: The technical work associated with electrical systems to be commissioned must be performed by an engineering technician with five years of experience inspecting,

testing, and calibrating electrical distribution and generation equipment, systems, and devices.

c. Cybersecurity Subject Matter Expert(s): Cybersecurity hardening of each FRCS to be commissioned must be performed by professional(s) who meet the qualification requirements of the edited specification 25 05 11 sections.

1.10 COMMISSIONING STANDARD

Comply with ASHRAE 202 and the commissioning standards under which the Commissioning Firm and Specialists qualifications are approved, which may include ACG Commissioning Guideline, NEBB S1110, or ANSI/SMACNA 014. In a conflict, the most stringent requirements apply. In addition, comply with ASHRAE 90.1 - IP commissioning requirements for all systems. Refer to related technical commissioning specification sections for additional standards requirements. Comply with applicable International Electrical Testing Association (NETA) testing standards for electrical systems. The following requirements apply to all project commissioning and test standards:

a. Implement all recommendations and suggested practices contained in the Commissioning Standard and test standards.

b. Use the Commissioning Standard for all aspects of Commissioning, including calibration of instruments.

c. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, adhere to the manufacturer calibration recommendations.

d. All quality assurance provisions of the Commissioning Standard such as performance guarantees are part of this contract.

e. The Commissioning Specialists must develop commissioning procedures for any systems or system components not covered in the Commissioning Standard.

f. Use any new requirements, recommendations, and procedures published or adopted by the body responsible for the applicable Commissioning Standards at the time of project award.

g. If there is a conflict between the requirements of the contract documents and the commissioning standard used, the contract documents take precedent.

1.11 ISSUES LOG

The Commissioning Specialist develops and maintains an Issues Log for the systems to be commissioned. The issues log documents and tracks resolution of deficiencies identified during submittal reviews, inspection, and testing. At any point during construction, any commissioning team member finding deficiencies may communicate those deficiencies in writing to the Commissioning Specialist for inclusion into the Issues Log. For each issue, the Issues Log includes, but is not limited to, a unique reference number, description of the issue with contract requirement referenced, location of or equipment name/tags exhibiting the issue, the initials of the individual's name whom reported the issue, the date of first observation, the proposed resolution of the

issue and date proposed, the date of any subsequent observations with applicable additional information, and the date of implementation of the final resolution of the issue as confirmed by the Commissioning Specialist and Contracting Officer. Issues must not be deleted from the issues log.

CxC must submit the Issues Log monthly and within three working days from changes to the Issue Log. The CxC is responsible for distributing the Issues Log to the Commissioning Team. QC Manager must track construction deficiencies identified in the Issues Log using a quality management system in accordance with Section 01 45 00.15 10 RESIDENT MANAGEMENT SYSTEM CONTRACTOR MODE(RMS CM) or 01 45 00 QUALITY CONTROL.

1.12 CERTIFICATE OF READINESS

Prior to scheduling Commissioning Tests for each system, the Quality Control Manager must issue a Certificate of Readiness for each system, certifying that inspections have been completed, open issues have been resolved, and the system is ready for Commissioning Tests. Refer to each related technical commissioning specification section for additional requirements.

Submit the Certificate of Readiness for each system 30 calendar days prior to Commissioning Tests of that system. Do not schedule Commissioning Tests for a system until the Certificate of Readiness is approved by the Government.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 DESIGN REVIEW

The CxC and other Commissioning Specialists must review design documents.

Provide a Design Review Report identifying discrepancies or deficiencies that would prevent the systems to be commissioned from operating or performing effectively or being adequately maintained. Report must include individual list of each deficiency and corresponding corrective action necessary for proper system performance. **Submit the Design Review Report no later than 14 calendar days after approval of the Commissioning Firm and Commissioning Specialists.** The Contracting Officer, the Contractor's Project Manager, the CxC, and the Designers of Record for the associated systems must meet, discuss, and resolve any outstanding items contained in the report no later than 14 calendar days after submission of the report.

3.2 CONSTRUCTION SUBMITTAL REVIEWS

Coordinate construction submittal document reviews for commissioned systems and assemblies with the CxC. The commissioning submittal review does not replace the Government submittal review, in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

The CxC must identify construction submittals to be provided by the contractor for the commissioned systems. The CxC must evaluate construction submittals for compliance with the contract documents prior to submission to the Government. Include a copy of CxC comments with the

construction submittals. Include a copy of the submittal document review transmittal and response in the Commissioning Report.

3.3 COMMISSIONING KICKOFF MEETING

Conduct a Commissioning Kickoff Meeting, led by the CxC, after approval of the Commissioning Firm and Commissioning Specialists, and no later than 30 days following approval of the Commissioning Firm and Specialists. Discuss the commissioning process including contract requirements, lines of communication, roles and responsibilities, schedules, documentation requirements, inspection and test procedures, and logistics as specified in this section.

The Contractor's Project Manager, Quality Control team, Designer of Record, and the Government must attend this meeting. Invite the User and Base Civil Engineering Representative to attend this meeting.

3.4 REGULAR COMMISSIONING COORDINATION MEETINGS

The Quality Control team, Designer of Record, and the Government must attend this meeting. Sub-Contractor Representatives for each trade responsible for construction/installation of systems to be commissioned must attend this meeting as requested by the CxC. Invite the User and a Base Civil Engineering Representative to attend this meeting.

CxC must conduct monthly commissioning coordination meetings when installation of commissioned systems begins. Provide status of commissioned systems, open issues log items, outstanding submittals, and upcoming commissioning activities. Conduct bi-weekly commissioning coordination meetings within 30 days of the scheduled date for commissioning testing.

3.5 CONSTRUCTION PHASE COMMISSIONING PLANS

The Interim Construction Phase Commissioning Plan identifies the commissioning and testing standards and outline the overall commissioning process, the commissioning schedule, the commissioning team members and responsibilities, lines of communication, documentation requirements for the construction phase of the project. Submit the Interim Construction Phase Commissioning Plan, prepared by the CxC, 14 calendar days after the Construction Commissioning Coordination Meeting and 14 days prior to the start of construction of the building enclosure. Include the following items in the commissioning schedule in addition to the items in paragraph PROJECT SCHEDULE: -Commissioning Site Visits, -Seasonal Testing, Warranty Phase Site Visit, Post-Construction Endurance Testing, and Updated Commissioning Report.

The Final Construction Phase Commissioning Plan includes the information provided in the Interim Construction Phase Commissioning Plan as well as commissioning construction observation checklists and test procedures such as Pre-Functional Checklists, Integrated Systems Test Checklists, and Functional Performance Test Checklists and other Commissioning Test Checklists for each building, for each system required to be commissioned, and for each component for inclusion in the Final Construction Phase Commissioning Plan. Refer to the related technical commissioning specification section for additional requirements for checklists. Submit the Final Construction Phase Commissioning Plan, prepared by the CxC, no later than 90 calendar days prior to the start of Commissioning Inspections.

3.5.1 Construction Observation Checklists

Construction Observation Checklists must include items for physical inspection or testing that demonstrate that installation and start-up of equipment and systems is complete. Refer to paragraph COMMISSIONING INSPECTIONS. Construction observation checklists must be tailored to verify the specific installation requirements and details of the construction documents and manufacturer's instructions.

3.5.2 Test Procedures and Checklists

Test procedures and checklists must include procedures that explain, step-by-step, the actions and expected results that will demonstrate that the systems perform in accordance with the contract. Refer to paragraph COMMISSIONING TESTS. Include the following sections and details appropriate to the systems being tested in the test procedures and checklists:

a. Notable system features including information about controls to facilitate understanding of system operation

b. Conclusions and recommendations. Conclusions must clearly indicate if system does or does not perform in accordance with contract requirements. Recommendation must clearly indicate that the system should or should not be approved by the Government.

c. Test conditions including date, beginning and ending time, and beginning and ending outdoor air conditions

d. Attendees

e. Identification of the equipment involved in the test

f. Control system feature identification

g. As-found condition of the system operation

h. List of test items with step numbers along with the corresponding feature or operation, intended test procedure, expected system response, and pass/fail indication.

i. Space for comments for each test item.

3.6 COMMISSIONING INSPECTIONS

Complete inspections using Construction Observation Checklists for each individual item of equipment or system for each system required to be commissioned in accordance with the commissioning plan. Indicate commissioning team member inspection and validation of each checklist item by initials. Validation of each checklist item by each team member indicates that item conforms to the contract documents and design in their area of responsibility. Commissioning Specialist validation of each checklist item indicates that each item has been installed correctly and in accordance with contract documents. Submit the initialed and Completed Construction Observation Checklists no later than 7 calendar days after completion of inspection of all checklists items for each system.

3.7 COMMISSIONING TESTS

Demonstrate that all systems, equipment, and components have been installed correctly and that the systems operate and perform, including interactive operation between systems, in accordance with contract documents. Perform tests as specified in related technical commissioning specifications. Provide all materials, services, and labor required to perform all commissioning tests.

Commissioning Specialist's duties include leading and documenting all tests for the systems to be commissioned with appropriate sub-contractors performing the Tests. The representatives listed in the paragraph COMMISSIONING TEAM must attend the tests with the exception of the Contractor's Project Manager.

3.7.1 Test Scheduling and Coordination

Schedule Commissioning Tests for each system only after the Certificate of Readiness has been approved by the Government for the system. Correct all deficiencies identified through any prior review, inspection, or test activity before the start of Commissioning tests.

Commissioning Tests and Integrated Systems Tests must be performed with the CxC present. Government reserves the right to witness all tests. Coordinate test schedule with Government representatives.

3.7.2 Testing Procedures

Commissioning tests include tests such as functional performance and integrated systems tests. For electrical systems testing, include testing of sensor calibrations, control responses, safeties, interlocks, operating modes, capacity, lighting levels, and verification of all other electrical system contract performance requirements. Perform test procedures in accordance with the commissioning standards specified. In addition, comply with the testing procedures specified in the sections listed in paragraph RELATED SECTIONS.

3.7.3 Aborted Tests and Re-Testing

Abort any test if any deficiency prevents successful completion of the test or if any required commissioning team member is not present for the test. Re-test after all deficiencies identified during the original test have been corrected. Contracting Officer may withhold payment equivalent to lost time, re-testing, and aborted tests. These costs may include salary, travel costs, and per diem for Government team members.

3.8 TRAINING PLAN

CxC must review the training plan for training associated with the equipment and systems to be commissioned, checking that each plan has the trainer name, trainer contract information, training schedule and location. Submit review at least 30 days prior to the first training event. Incorporate CxC review comments prior to submitting training plan in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Update and resubmit the training plan based on any corrective action taken.

3.9 SYSTEMS MANUAL

Prepare and submit a Systems Manual, including a signed certification or

letter from the Commissioning Specialists and the CxC stating that the Systems Manual is complete, clear, and accurate. The Systems Manual, for all commissioned systems, must conform to Appendix A SYSTEMS MANUAL ORGANIZATION AND CONTENT per ER 25-345-1, available at the USACE Publications website at the following location: https://www.publications.usace.army.mil/USACE-Publications/Engineer-Regulations/. Obtain the Basis of Design for incorporation into the Systems Manual from the Contracting Officer. Submit Systems Manual no later than 30 calendar days following completion of Functional Performance Tests and Integrated Systems Tests. Update and resubmit the Systems Manual based on any corrective action taken during the warranty period.

Ensure Systems Manual is coordinated with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA and Quality Control requirements.

3.10 MAINTENANCE AND SERVICE LIFE PLAN

3.10.1 Maintenance Plan

Prepare and submit a Maintenance Plan for the project mechanical, electrical, plumbing, and fire protection systems. Prepare the HVAC and refrigeration sections of the Maintenance Plan in accordance with ASHRAE 180. Develop required inspection and maintenance tasks similar to Section 5 of ASHRAE 180 for the other commissioned systems and fire protection systems. Ensure Maintenance Plan is coordinated with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Submit the Maintenance Plan no later than 30 calendar days following the completion of Functional Performance Tests and Integrated Systems Tests.

3.10.2 Service Life Plan

Prepare and submit a Service Life Plan for the building enclosure, structural systems, and site hardscape that includes the following for each assembly or component:

a. A description of each including the materials or products.

b. The estimated service life, in years.

c. The estimated maintenance frequency and description of maintenance tasks.

d. The point of maintenance access for the components with estimated service life less than service life of the building.

Ensure Service Life Plan is coordinated with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit the Service Life Plan no later than 30 calendar days following the completion of Functional Performance Tests and Integrated Systems Tests.

3.11 COMMISSIONING REPORT

Submit an Final Commissioning Report no later than 14 calendar days following commissioning team validation of all Commissioning Tests, including Functional Performance Tests, and Integrated Systems Tests, with the exception of Seasonal Tests. Include the following information in the Final Commissioning Report:

a. An executive summary describing the overall commissioning process, the results of the commissioning process, outstanding deficiencies and recommended resolutions, and seasonal testing that must be scheduled for a later date. Indicate, in the executive summary, whether the systems meet the requirements of the contract documents.

b. A list of deficiencies discovered during the commissioning process and the corrective actions taken in the report.

c. Pre-Functional Checklists and other Commissioning Observation Checklists, Commissioning Test Checklists such as Functional Performance Test Checklists and Integrated Systems Test Checklists,, the Air Leakage Test Reports and Diagnostic Test Reports, the Final Construction Phase Commissioning Plan, the Issues Log, Training Attendance Rosters, the Design Review Reports, Submittal Review Report, and any other documents as specified by related technical commissioning specification sections.

3.12 WARRANTY PHASE SITE VISIT

The Lead Commissioning Specialist must visit the building site concurrent with the 9 month warranty inspection to inspect building system equipment and review building operation with the building operating/maintenance staff, and identify any deficiency of the building systems to operate in accordance with the contract documents. The Commissioning Specialist must notify the Contracting Officer of any identified deficiencies and the proposed corrective action. Submit Updated Final Commissioning Report and Systems Manuals, documenting the results of the warranty phase inspection. Include other warranty or post-construction phase activities as specified in related technical commissioning specification sections, such as Seasonal testing results and Post-Construction Endurance Test and Trend Log Report.

-- End of Section --

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SECTION 02 41 00

DEMOLITION AND DECONSTRUCTION
08/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.6	(2006) Safety & Health Program Requirements for Demolition Operations - American National Standard for Construction and Demolition Operations

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 82	Protection of Stratospheric Ozone

1.2 PROJECT DESCRIPTION

1.2.1 Definitions

1.2.1.1 Demolition

Demolition is the process of tearing apart and removing any feature of a facility together with any related handling and disposal operations.

1.2.1.2 Deconstruction

Deconstruction is the process of taking apart a facility with the primary goal of preserving the value of all useful building materials.

1.2.1.3 Demolition Plan

Demolition Plan is the planned steps and processes for managing demolition activities and identifying the required sequencing activities and disposal mechanisms.

1.2.1.4 Deconstruction Plan

Deconstruction Plan is the planned steps and processes for dismantling all or portions of a structure or assembly, to include managing sequencing activities, storage, re-installation activities, salvage and disposal

mechanisms.

1.2.2 Demolition/Deconstruction Plan

Prepare a Demolition/Deconstruction Plan and submit proposed salvage, demolition and deconstruction, and removal procedures for approval before work is started. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress, a disconnection schedule of utility services, a detailed description of methods and equipment to be used for each operation and of the sequence of operations. Coordinate with Waste Management Plan in accordance with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL. Provide procedures for safe conduct of the work in accordance with EM 385-1-1. Plan must be approved by Contracting Officer prior to work beginning.

1.2.3 General Requirements

See Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION for required demolition permit needed for each facility. Do not begin demolition or deconstruction until authorization is received from the Contracting Officer. Remove rubbish and debris daily from the project site. The work includes demolition, deconstruction, salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer. In the interest of occupational safety and health, perform the work in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections.

1.3 ITEMS TO REMAIN IN PLACE

Comply with FAR 52.236-9 to protect existing vegetation, structures, equipment, utilities, and improvements. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract. Do not overload pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer prior to performing such work.

1.3.1 Trees

Protect trees within the project site which might be damaged during demolition or deconstruction, and which are indicated to be left in place, by a 6 foot high fence. Erect and secure fence a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Contracting Officer.

1.3.2 Utility Service

Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations.

1.4 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.5 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available at contract award.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Demolition/Deconstruction Plan; G-RO

Existing Conditions

SD-07 Certificates

Notification; G, RO

1.7 QUALITY ASSURANCE

Submit timely notification of demolition projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. Notify the State's environmental protection agency and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSP A10.6. Comply with the Environmental Protection Agency requirements specified. Use of explosives will not be permitted.

1.7.1 Dust and Debris Control

Prevent the spread of dust and debris and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

1.8 PROTECTION

1.8.1 Traffic Control Signs

a. Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Notify the Contracting Officer prior to beginning such work.

1.8.2 Protection of Personnel

Before, during and after the demolition work continuously evaluate the

condition of the site specific features and structures being demolished and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.9 EXISTING CONDITIONS

Before beginning any demolition work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Contracting Officer or the Contracting Officer's Representative showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs or electronic images with a minimum resolution of 3072 x 2304 pixels, capable of a print resolution of 300 dpi, will be acceptable as a record of existing conditions. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, alarms systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document. Submit survey results to the Contracting Officer or the Contracting Officer's Representative.

PART 2 PRODUCTS

2.1 FILL MATERIAL

See 31 00 00 EARTHWORK for requirements.

PART 3 EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

Disassemble existing construction to be demolished/deconstructed for re cycling to the extent feasible within the local area. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal.

3.1.1 Structures

a. Remove existing structures indicated completely and shall include all of the foundations. Remove sidewalks, curbs, gutters and street light bases in the area of demolition for the new work.

b. Demolish structures in a systematic manner from the top of the structure to the ground. Complete demolition work above each tier or floor before the supporting members on the lower level are disturbed. Demolish concrete and masonry walls in small sections. Remove structural framing members and lower to ground by means of derricks, platforms hoists, or other suitable methods as approved by the Contracting Officer.

c. Locate demolition and deconstruction equipment throughout the structure and remove materials so as to not impose excessive loads to

supporting walls, floors, or framing.

d. Buildings not exceeding 80 feet in height may be demolished by the mechanical method of demolition.

3.1.2 Utilities and Related Equipment

3.1.2.1 General Requirements

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Contracting Officer. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition or deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.1.2.2 Disconnecting Existing Utilities

Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer. When utility lines are encountered but are not indicated on the drawings, notify the Contracting Officer prior to further work in that area. Remove meters and related equipment and deliver to a location in accordance with instructions of the Contracting Officer.

3.1.3 Chain Link Fencing

Remove chain link fencing and gates in their entirety and recycle to the extent feasible.

3.1.4 Paving and Slabs

Remove concrete and asphaltic concrete paving and slabs in their entirety . Provide neat sawcuts at limits of pavement removal. Move, grind and store pavement and slabs designated to be recycled and utilized in this project as directed by the Contracting Officer.

3.1.5 Concrete

Saw concrete and remove in its entirety as indicated. Move, grind and store pavement and slabs designated to be recycled and utilized in this project as directed by the Contracting Officer. Sawcuts in existing concrete sidewalk, roads concrete pads ,parking areas, must be at the nearest existing expansion joint or weakened plane joint and at full depth.

3.1.6 Structural Steel

Salvage for recycle structural steel, steel joists, girders, angles, plates, columns and shapes. Do not use flame-cutting torches. Transport steel joists and girders as whole units and not dismantled. Transport structural steel shapes to a recycling facility, stacked according to size, type of member and length, and stored off the ground, protected from the weather.

3.1.7 Miscellaneous Metal

Salvage shop-fabricated items such as access doors and frames, steel

gratings, metal ladders, wire mesh partitions, metal railings, metal windows and similar items for recyclying to the extent feasible. Salvage light-gage and cold-formed metal framing, such as steel studs, steel trusses, metal gutters, roofing and siding, metal toilet partitions, toilet accessories and similar items. Scrap metal is the Contractor's property. Recycle scrap metal as part of demolition and deconstruction operations. Provide separate containers to collect scrap metal and transport to a scrap metal collection or recycling facility, in accordance with the Waste Management Plan.

3.1.8 Carpentry

Salvage for recycle lumber, millwork items, and finished boards, as feasible. Chip or shred and recycle salvaged wood unfit for reuse, except stained, painted, or treated wood. Salvage windows, doors, frames, and cabinets, and similar items as whole units, complete with trim and accessories. Do not remove hardware attached to units, except for door closers. Brace the open end of door frames to prevent damage. Send to local salvage company.

3.1.9 Carpet

Remove existing carpet and any carpet cushion for reclamation in accordance with manufacturer recommendations as feasible.

3.1.10 Acoustic Ceiling Tile

Remove, neatly stack, and recycle acoustic ceiling tiles. Recycling may be available with manufacturer. Otherwise, give priority to a local recycling organization. Recycling is not required if the tiles contain or may have been exposed to asbestos material.

3.1.11 Cylinders and Canisters

Remove all fire suppression system cylinders and canisters. If products contain ozone depleting substances, remove recovered ODS from Government property and dispose of in accordance with 40 CFR 82."

3.1.12 Locksets on Swinging Doors

Remove all locksets from all swinging doors. Deliver the locksets and related items to a designated location for receipt by the CES after removal.

3.1.13 Mechanical Equipment and Fixtures

Coordinate with CES any mechanical equipment that CES wishes to salvage. Removal will be done by CES. Remove any remaining mechanical equipment and fixtures in their entirety.

3.1.13.1 Ducts

Classify removed duct work as scrap metal.3.1.14 Electrical Equipment and Fixtures

Coordinate with CES any electrical equipment that CES wishes to salvage. Removal will be done by CES. Remove any remaining electrical equipment and fixtures in their entirety.

3.1.15 Elevators and Hoists

Remove Elevators and Hoists in their entirety..

3.2 CONCURRENT EARTH-MOVING OPERATIONS

Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition in areas occupied by structures to be demolished or deconstructed until all demolition and deconstruction in the area has been completed and debris removed. Fill holes, open pits, and other hazardous openings.

3.3 DISPOSITION OF MATERIAL

3.3.1 Title to Materials

Except for salvaged items specified in related Sections, and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, become the property of the Contractor and must be removed from Government property. Materials approved for storage by the Contracting Officer must be removed before completion of the contract. Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

3.3.2 Unsalvageable and Non-Recyclable Material

Dispose of unsalvageable and non-recyclable noncombustible material off base.

3.4 CLEANUP

Remove debris and rubbish from project site and similar excavations. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.5 DISPOSAL OF REMOVED MATERIALS

3.5.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations with all applicable federal, state and local regulations as contractually specified.

3.5.2 Burning on Government Property

Burning of materials removed from demolished and deconstructed structures will not be permitted on Government property.

3.5.3 Removal to Spoil Areas on Government Property

Transport noncombustible materials removed from demolition and deconstruction structures to designated spoil areas on Government property.

3.5.4 Removal from Government Property

Transport waste materials removed from demolished and deconstructed structures, except waste soil, from Government property for legal disposal. Dispose of waste soil per Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

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SECTION 02 61 13

EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL
02/10, CHG 1: 02/21

PART 1 GENERAL

Regulated asbestos containing soil (RACS) is not known to be present on the site. However, the Contractor shall take precautions in the event that buried building debris is uncovered during excavation activities. The Contractor shall have a Colorado Certified Asbestos Building Inspector (CABI) onsite during excavation. The CABI must be a Tier I subcontractor.

Installation procedures for soil disturbance include processing a dig permit through 460 CES. Site workers and management shall observe soils during excavation activities. If any construction debris or unknown material is encountered:

1) Soils disturbing activities will cease and access controls shall be installed,
2) The USACE KO and 460 CES/CEIE shall be notified the same day of discovery (Mr. Matt Christensen: 720-847-5723, matthew.christensen.11@spaceforce.mil)
3) the debris or material shall not be disturbed, and shall be stabilized by placing poly sheeting over the soils,
4) the debris or material must be evaluated by a Certified Asbestos Building Inspector (CABI) with RACS experience,
    4a.) If the debris or materials do not contain asbestos, the 460 CES/CEIE or 460 CES Customer Service shall evaluate the CABI report prior to authorizing the work to continue.
    4b) If asbestos materials are present, no additional excavation will occur until the asbestos material is removed by qualified personnel and the soils are cleared in accordance with the Buckley AFB Specific RACS Management Plan.
5) The project proponent is responsible for pulling required permits and maintaining stabilization sheeting and access controls until the asbestos containing materials are properly removed or the site is otherwise managed.

The history of the area near the site (but not within the site) included a tank removal with removal of petroleum-related contaminated soil (benzene and polycyclic aromatic hydrocarbons/PAHs). The site was identified as Truck Fueling Area TA564 and the removal was conducted in 2023. The Remedial Action Construction Completion Report is dated August 2024 and indicates in addition to tank and soil removal, oxidant was placed in the excavation, and oxidant was injected to remediate contaminated groundwater. It is not believed that any soil contamination is present in the proposed project area. If any soil contamination other than asbestos is uncovered, notify the Contracting Officer and 460 CES/CENM.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Buckley Air Force Base Specific Regulated Asbestos Contaminated Soil Management Plan, Buckley Air Force Base, Colorado March 2016

ASTM INTERNATIONAL (ASTM)

ASTM D5434	(2012) Field Logging of Subsurface Explorations of Soil and Rock

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction
40 CFR 302	Designation, Reportable Quantities, and Notification

1.2 DESCRIPTION OF WORK

The work consists of excavation and temporary storage of any contaminated material that is encountered during required excavation work for the project. Submit a Work Plan as specified below. Notify the Contracting Officer within 24 hours, and before excavation, if contaminated material, construction debris, or unknown material is discovered that has not been previously identified or if other discrepancies are discovered.

1.2.1 Scheduling

Notify the Contracting Officer 10 calendar days prior to the start of excavation of any contaminated material that is uncovered. The Contractor is responsible for contacting 460 CES/CEIE and regulatory agencies in accordance with the applicable reporting requirements and to obtain any applicable permits prior to excavation.

1.2.2 Work Plan

If contaminated soil, debris or materials determined by a CABI to contain asbestos are encountered, submit a Work Plan within 20 calendar days after encountering debris the asbestos-containing debris. Do not perform work at the site, with the except site inspections and surveys, until the Work Plan is approved by the Contracting Officer and 460 CES/CEIE. Allow 30 calendar days in the schedule for the Government's review. No adjustment for time or money will be made if resubmittals of the Work Plan are required due to deficiencies in the plan. At a minimum, include the following in the the Work Plan:

a. Schedule of activities.

b. Method of excavation and equipment to be used.

c. Shoring or side-wall slopes proposed.

d. Dewatering plan.

e. Storage methods and locations for liquid and solid contaminated material.

f. Borrow sources and haul routes.

g. Decontamination procedures.

h. Spill contingency plan.

i. Other topics as required by 460 CES/CEIE.

1.2.3 Other Submittal Requirements

Submit a Closure Report within 14 calendar days of work completion at the site.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan; G, RO

SD-06 Test Reports

Closure Report; G, RO

1.4 REGULATORY REQUIREMENTS

1.4.1 Permits and Licenses

Obtain required federal, state, and base permits for excavation and storage of contaminated material. Obtain permits at no additional cost to the Government.

1.4.2 Air Emissions

Monitor and control air emissions in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

PART 2 PRODUCTS

2.1 SPILL RESPONSE MATERIALS

Provide appropriate spill response materials including, but not limited to the following: containers, adsorbents, shovels, and personal protective equipment. Make spill response materials available at all times when contaminated materials/wastes are being handled or transported. Provide spill response materials that are compatible with the type of materials and contaminants being handled.

2.2 BACKFILL

Comply with the requirements of section 31 00 00 EARTHWORK.

PART 3 EXECUTION

3.1 EXISTING STRUCTURES AND UTILITIES

Do not perform excavation until site utilities have been field located. Take the necessary precautions to ensure no damage occurs to existing structures and utilities. Repair any damage to existing structures and utilities resulting from the Contractor's operations at no additional cost to the Government. Do not disturb utilities encountered that were not previously shown or otherwise located without approval from the Contracting Officer.

3.2 CLEARING

Perform clearing to the limits shown on the drawings in accordance with Section 31 11 00 CLEARING AND GRUBBING.

3.3 CONTAMINATED MATERIAL REMOVAL

3.3.1 Excavation

Excavate areas of contamination to the depth and extent shown on the drawings unless directed by the Contracting Officer. Perform excavation in a manner that will limit spills and the potential for contaminated material to be mixed with uncontaminated material. Maintain an excavation log for each area of excavation. Prepare excavation logs in accordance with ASTM D5434. Where potentially contaminated material or RACS are encountered, handle in accordance with the approved Work Plan submitted to the Contracting Officer and 460 CES/CEIE.

3.3.2 Shoring

If workers must enter the excavation, evaluate, shore, slope or brace it as required by EM 385-1-1 and 29 CFR 1926 section 650.

3.3.3 Dewatering

Divert surface water to prevent entry into the excavation. Limit dewatering to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met. Do not perform dewatering without prior approval of the Contracting Officer.

3.4 CONTAMINATED MATERIAL STORAGE

Place material in temporary storage immediately after excavation. The following paragraphs describe acceptable methods of material storage. Provide storage units that are in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, clearly label each unit with an identification number and keep a written log to track the source of contaminated material in each temporary storage unit. Use temporary storage as identified in the approved Work Plan.

3.4.1 Stockpiles

Construct stockpiles to isolate stored contaminated material from the environment. Construct stockpiles to include:

a. A chemically resistant geomembrane liner free of holes and other damage. Provide non-reinforced geomembrane liners that have a minimum thickness of 20 mils. Provide scrim reinforced geomembrane liners that have a minimum weight of 40 lbs/1000 square feet. Place the geomembrane on a ground surface that is free of rocks greater than 0.5 inches in diameter and any other object which could damage the membrane.

b. Geomembrane cover free of holes or other damage to prevent precipitation from entering the stockpile. Provide non-reinforced geomembrane covers that have a minimum thickness of 10 mils. Provide scrim reinforced geomembrane covers that have a minimum weight of 26 lbs/1000 square feet. Extend the cover material over the berms and anchor or ballast to prevent it from being removed or damaged by wind.

c. Berms surrounding the stockpile, a minimum of 12 inches in height. Berm vehicle access points.

d. Slope the liner system to allow collection of leachate. Storage and removal of liquid which collects in the stockpile, in accordance with paragraph Liquid Storage.

3.4.2 Roll-Off Units

Use water-tight roll-off units used to temporarily store contaminated material. Place a cover over the units to prevent precipitation from contacting the stored material. Locate the units as approved by the Contracting Officer. Remove liquid which collects inside the units and store in accordance with paragraph Liquid Storage.

3.4.3 Liquid Storage

Temporarily store liquid collected from excavations and stockpiles in appoved barrels or tanks. Provide water-tight liquid storage containers and locate in areas approved by the Contracting Officer.

3.5 SAMPLING

If sampling is appropriate, the Contractor shall proposed analytical parameters and frequency of sampling in the Work Plan for approval.

3.6 SPILLS

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), pollutant, contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), notify the Contracting Officer immediately. If the spill exceeds the reporting threshold, follow the pre-established procedures as required by 460 CES for immediate reporting and containment. Take immediate containment actions to minimize the effect of any spill or leak. Perform cleanup in accordance with applicable federal, state, and local regulations. As directed by the Contracting Officer, perform additional sampling and testing to verify spills have been cleaned up. Perform spill cleanup and testing at no

additional cost to the Government.

3.7 DISPOSAL REQUIREMENTS

Perform offsite disposal of contaminated material in accordance with the approved Work Plan.

3.8 CLOSURE REPORT

Submit a Closure Report within 14 calendar days of completing work at the site. Label the report with the contract number, project name, location, date, name of general Contractor, and the Corps of Engineers District contracting for the work. As a minimum, include the following information:

a. A cover letter signed by a responsible company official certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.

b. A narrative report including, but not limited to, the following:

(1) site conditions, ground water elevation, and any cleanup criteria;

(2) excavation logs;

(3) field screening readings (if required);

(4) quantity of materials removed from each area;

(5) quantity of water/product removed during dewatering;

(6) sampling locations and sampling methods (if sampling is required);

(7) sample collection data such as time of collection and method of preservation;

(8) sample chain-of-custody forms; and

c. Copies of all chemical and physical test results (as applicable to the project).

d. Copies of all manifests and land disposal restriction notifications (as applicable to the project).

e. Copies of all certifications of final disposal signed by the responsible disposal facility official (as applicable to the project).

f. Waste profile sheets (as applicable to the project).

g. Progress Photographs. Use color photographs to document progress of the work. Take a minimum of four views of the site showing the location of the area of contamination, entrance/exit road, and any other notable site conditions before work begins. After work has been started, photographically record daily activities at each work location. Provide digital photographs and include:

(1) Soil removal and sampling.

(2) Dewatering operations.

(3) Unanticipated events such as spills and the discovery of additional contaminated material.

(4) Contaminated material/water storage, handling, treatment, and transport (as applicable to the project).

(5) Site or task-specific employee respiratory and personal protection.

(6) Fill placement and grading.

(7) Post-construction photographs. After completion of work at each site, take a minimum of four views of each excavation site.

Include a digital version of all photos shown in the report with the Closure Report.

-- End of Section --

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SECTION 02 82 00

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ATTACHMENTS:

-Assessment of Suspect Asbestos-Containing Building Materials, Building 417, Buckley Air Force Base, CO, 28 March 2005

-Visual Survey for Asbestos-Containing Materials, Building 423, Buckley Air Force Base, CO 8 February 2006

-Limited Asbestos Inspection for Renovation, Buckley Space Force Base, Building 423, May 30, 2025

-Facility Maintenance Plan, Building 424, Buckley Air Force Base, CO, 15 February 2006

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ASBESTOS REMEDIATION
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PART 1 GENERAL

Attachments:
-Assessment of Suspect Asbestos-Containing Building Materials, Building 417, Buckley Air Force Base, CO, 28 March 2005
-Visual Survey for Asbestos-Containing Materials, Building 423, Buckley Air Force Base, CO 8 February 2006
-Limited Asbestos Inspection for Renovation, Buckley Space Force Base, Building 423, May 30, 2025
-Facility Maintenance Plan, Building 424, Buckley Air Force Base, CO, 15 February 2006

Buildings 417, 423, and 424 are scheduled for demolition as part of this project. Previous surveys for asbestos were conducted and are attached to this specification. No asbestos was detected as part of these prior efforts. However, because the previous surveys were not comprehensive for demolition purposes, an asbestos survey, and survey of other hazardous materials for these buildings is required. Prior to demolition, the Contractor shall obtain a hazardous materials survey (including asbestos survey, lead-containing paint survey and other hazardous or regulated materials) for these three buildings. The asbestos survey shall comply with applicable Federal and Colorado asbestos regulations and the individual performing asbestos sampling shall be a Colorado-certified asbestos building inspector. The Contractor performing the hazardous materials survey must be a Tier 1 subcontractor. The survey shall sample and analyze for asbestos in suspect building materials using polarized light microscopy (PLM) and an accredited laboratory. Laboratory results shall be provided to the KO. Where ACM is impacted by the planned demolition, these materials shall be removed and properly disposed as required by this specification and in accordance with Colorado and Federal regulations.

In addition to Federal and state regulations, the Contractor shall comply with the Buckley Asbestos Management and Operations Plan, and the Buckley Specific Regulated Asbestos Contaminated Soil Management Plan.

For information regarding any potential asbestos in the soil at the site, see section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z9.2	(2018) Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems

ASTM INTERNATIONAL (ASTM)

ASTM D4397	(2016) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7	(2014) Compressed Air for Human Respiration; 6th Edition

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2020) Occupational and Educational Personal Eye and Face Protection Devices

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH NMAM	(2016; 5th Ed) NIOSH Manual of Analytical Methods

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 340/1-90/018	(1990) Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1926.51	Sanitation
29 CFR 1926.59	Hazard Communication
29 CFR 1926.103	Respiratory Protection
29 CFR 1926.200	Accident Prevention Signs and Tags
29 CFR 1926.1101	Asbestos
40 CFR 61-SUBPART A	General Provisions
40 CFR 61-SUBPART M	National Emission Standard for Asbestos
40 CFR 763	Asbestos
42 CFR 84	Approval of Respiratory Protective Devices
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 171	General Information, Regulations, and Definitions

49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings

UL SOLUTIONS (UL)

UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units

Buckley Air Force Base Asbestos Management and Operations Plan, 15 October 2016

1.2 DEFINITIONS

1.2.1 ACM

Asbestos Containing Materials.

1.2.2 Amended Water

Water containing a wetting agent or surfactant with a maximum surface tension of 0.00042 psi.

1.2.3 Area Sampling

Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.

1.2.4 Asbestos

The term asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, and actinolite asbestos and any of these minerals that has been chemically treated or altered. Materials are considered to contain asbestos if the asbestos content of the material is determined to be at least one percent.

1.2.5 Asbestos Control Area

That area where asbestos removal operations are performed which is isolated by physical boundaries which assist in the prevention of the uncontrolled release of asbestos dust, fibers, or debris.

1.2.6 Asbestos Fibers

Those fibers having an aspect ratio of at least 3:1 and longer than 5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 7400.

1.2.7 Asbestos Permissible Exposure Limit

0.1 fibers per cubic centimeter of air as an 8-hour time weighted average measured in the breathing zone as defined by 29 CFR 1926.1101 or other Federal legislation having legal jurisdiction for the protection of

workers health.

1.2.8 Authorized Person

Any person authorized by the Contractor and required by work duties to be present in the regulated areas.

1.2.9 Background

The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for other (contaminated) areas are measured in similar but asbestos free locations.

1.2.10 Competent Person (CP)

A person meeting the requirements for competent person as specified in 29 CFR 1926.1101 including a person capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, and is specifically trained in a training course which meet the criteria of EPA's Model Accreditation Plan (40 CFR 763) for project designer or supervisor, or its equivalent. The competent person must have a current State of Colorado asbestos contractors or supervisors license/certification.

1.2.11 Contractor

The Contractor is that individual, or entity under contract to perform the herein listed work.

1.2.12 Disposal Bag

A 6 mil thick, leak-tight plastic bag, pre-labeled in accordance with 29 CFR 1926.1101, used for transporting asbestos waste from containment to disposal site.

1.2.13 Disturbance

Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM. Disturbance includes cutting away small amounts of ACM, no greater than the amount which can be contained in one standard sized glovebag or waste bag, not larger than 60 inches in length and width in order to access a building component.

1.2.14 Friable Asbestos Material

A term defined in 40 CFR 61-SUBPART M and EPA 340/1-90/018 meaning any material which contains more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Polarized Light Microscopy (PLM), that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

1.2.15 Glovebag Technique

Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.

1.2.16 HEPA Filter Equipment

High efficiency particulate air (HEPA) filtered vacuum and exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters must retain 99.97 percent of particles 0.3 microns or larger as indicated in UL 586.

1.2.17 Model Accreditation Plan (MAP)

USEPA training accreditation requirements for persons who work with asbestos as specified in 40 CFR 763.

1.2.18 Negative Pressure Enclosure (NPE)

That engineering control technique described as a negative pressure enclosure in 29 CFR 1926.1101.

1.2.19 NESHAP

National Emission Standards for Hazardous Air Pollutants. The USEPA NESHAP regulation for asbestos is at 40 CFR 61-SUBPART M.

1.2.20 Nonfriable Asbestos Material

Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, removal, or mishap.

1.2.21 Permissible Exposure Limits (PELs)

1.2.21.1 PEL-Time Weighted Average(TWA)

Concentration of asbestos not in excess of 0.1 fibers per cubic centimeter of air (f/cc) as an 8-hour time weighted average (TWA).

1.2.21.2 PEL-Excursion Limit

An airborne concentration of asbestos not in excess of 1.0 f/cc of air as averaged over a sampling period of 30 minutes.

1.2.22 Personal Sampling

Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with 29 CFR 1926.1101.

1.2.23 Private Qualified Person (PQP)

That qualified person hired by the Contractor to perform the herein listed tasks.

1.2.24 Qualified Person (QP)

A Registered Architect, Professional Engineer, Certified Industrial Hygienist, consultant or other qualified person who has successfully completed training and is therefore accredited under a legitimate State

Model Accreditation Plan as described in 40 CFR 763 as a Building Inspector, Contractor/Supervisor Abatement Worker, and Asbestos Project Designer; and has successfully completed the National Institute of Occupational Safety and Health (NIOSH) 582 course "Sampling and Evaluating Airborne Asbestos Dust" or equivalent. The QP must be appropriately licensed/certified as an air monitoring specialist in the State of Colorado.

1.2.25 TEM

Refers to Transmission Electron Microscopy.

1.2.26 Time Weighted Average (TWA)

The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.

1.2.27 Transite

A generic name for asbestos cement wallboard and pipe.

1.2.28 Wetting Agent

A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 0.00042 psi.

1.2.29 Worker

Individual (not designated as the Competent Person or a supervisor) who performs asbestos work and has completed asbestos worker training required by 29 CFR 1926.1101, and state of Colorado regulations, if required by the OSHA Class of work to be performed or by the state where the work is to be performed. The worker must be appropriately licensed/certified in the State of Colorado.

1.3 REQUIREMENTS

1.3.1 Description of Work

The work covered by this section includes the handling and control of asbestos containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of any asbestos containing materials generated by the work. More specific operational procedures must be outlined in the Asbestos Hazard Abatement Plan called for elsewhere in this specification. The asbestos work includes the removal of asbestos-containing material impacted by project work. Provide negative pressure enclosure techniques as outlined in this specification. The work area will be evacuated during the asbestos abatement work. A competent person must supervise asbestos removal work as specified herein.

1.3.2 Unexpected Discovery of Asbestos

Notify the Contracting Officer if any previously untested building components suspected to contain asbestos are impacted by the work.

1.3.3 Medical Requirements

Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.

1.3.3.1 Medical Examinations

Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent State or local directives. This requirement must have been satisfied within the 12 months prior to the start of work on this contract. The same medical examination must be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word "ASBESTOS."

1.3.3.2 Medical Records

Maintain complete and accurate records of employees' medical examinations, medical records, and exposure data for a period of 50 years after termination of employment and make records of the required medical examinations and exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational Safety and Health (OSHA), or authorized representatives of them, and an employee's physician upon the request of the employee or former employee.

1.3.4 Employee Training

Submit certificates, prior to the start of work but after the main abatement submittal, signed by each employee indicating that the employee has received training in the proper handling of materials and wastes that contain asbestos in accordance with 40 CFR 763 and state of Colorado regulations; understands the health implications and risks involved, including the illnesses possible from exposure to airborne asbestos fibers; understands the use and limits of the respiratory equipment to be used; and understands the results of monitoring of airborne quantities of asbestos as related to health and respiratory equipment as indicated in 29 CFR 1926.1101 on an initial and annual basis. Train personnel involved in the asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or State training criteria whichever is more stringent. Document the training by providing: dates of training, training entity, and names of instructors upon request by the Contracting Officer. Furnish each employee with respirator training and fit testing as required by 29 CFR 1926.1101 and 29 CFR 1926.103. Fully cover engineering and other hazard control techniques and procedures. Asbestos workers must have a current State of Colorado asbestos worker's license /certification.

1.3.5 Permits and Notifications

Prior to the start of work, obtain necessary permits in conjunction with asbestos removal, demolition, hauling, and disposition, and furnish notification of such actions required by Federal, State, regional, and local authorities. Notify the State's environmental protection agency and the Contracting Officer in writing 10 working days prior to commencement of work in accordance with 40 CFR 61-SUBPART M. Submit copies of all

Notifications to the Contracting Officer.

1.3.6 Environment, Safety and Health Compliance

In addition to detailed requirements of this specification, comply with those applicable laws, ordinances, criteria, rules, and regulations of Federal, State, regional, and local authorities regarding handling, storing, transporting, and disposing of asbestos waste materials. Comply with the applicable requirements of the current issue of EM 385-1-1, 29 CFR 1926.1101, 40 CFR 61-SUBPART A, 40 CFR 61-SUBPART M, and 40 CFR 763 . Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the work. Where the requirements of this specification, applicable laws, rules, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirement as defined by the Government apply. The following laws, ordinances, criteria, rules and regulations regarding removal, handling, storing, transporting and disposing of asbestos materials apply:

6 CCR 1007-2 Part 1, Section 5
5 CCR 1001-10, Regulation 8

1.3.7 Respiratory Protection Program

Establish and implement a respirator program as required by 29 CFR 1926.1101, and 29 CFR 1926.103. Submit a written description of the program to the Contracting Officer.

1.3.7.1 Respirator Program Records

Submit records of the respirator program as required by 29 CFR 1926.103, and 29 CFR 1926.1101.

1.3.7.2 Respirator Fit Testing

The Contractor must conduct a qualitative or quantitative fit test conforming to 29 CFR 1926.103 for each worker required to wear a respirator, and any authorized visitors who enter a regulated area where respirators are required to be worn. A respirator fit test must be performed prior to initially wearing a respirator and every 12 months thereafter. If physical changes develop that will affect the fit, a new fit test must be performed. Functional fit checks must be performed each time a respirator is put on and in accordance with the manufacturer's recommendation.

1.3.7.3 Respirator Selection and Use Requirements

Provide respirators, and ensure that they are used as required by 29 CFR 1926.1101 and in accordance with CGA G-7 and the manufacturer's recommendations. Respirators must be approved by the National Institute for Occupational Safety and Health NIOSH, under the provisions of 42 CFR 84, for use in environments containing airborne asbestos fibers. For air-purifying respirators, the particulate filter must be high-efficiency particulate air (HEPA)/(N-,R-,P-100). The initial respirator selection and the decisions regarding the upgrading or downgrading of respirator type must be made by the Contractor based on the measured or anticipated airborne asbestos fiber concentrations to be encountered.

1.3.8 Asbestos Hazard Control Supervisor

The Contractor must be represented on site by a supervisor, trained using the model Contractor accreditation plan as indicated in the Federal statutes for all portions of the herein listed work.

1.3.9 Hazard Communication

Adhere to all parts of 29 CFR 1926.59 and provide the Contracting Officer with a copy of the Safety Data Sheets (SDS) for all materials brought to the site.

1.3.10 Asbestos Hazard Abatement Plan

Submit a detailed plan of the safety precautions such as lockout, tagout, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan, not to be combined with other hazard abatement plans, must be prepared, signed, and sealed by the Contractor. The plan must include but not be limited to the precise personal protective equipment to be used including, but not limited to, respiratory protection, type of whole-body protection, the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos sealer to be used, locations of local exhaust equipment, planned air monitoring strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan must also include (both fire and medical emergency) response plans and an Activity Hazard Analyses (AHAs) in accordance with EM 385-1-1. The Asbestos Hazard Abatement Plan must be approved in writing prior to starting any asbestos work. The Contractor, Asbestos Hazard Control Supervisor, CP and PQP must meet with the Contracting Officer prior to beginning work, to discuss in detail the Asbestos Hazard Abatement Plan, including work procedures and safety precautions. Once approved by the Contracting Officer, the plan will be enforced as if an addition to the specification. Any changes required in the specification as a result of the plan must be identified specifically in the plan to allow for free discussion and approval by the Contracting Officer prior to starting work.

1.3.11 Testing Laboratory

Submit the name, address, and telephone number of each testing laboratory selected for the analysis, and reporting of airborne concentrations of asbestos fibers along with certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and successful participation of the laboratory in the Proficiency Analytical Testing (PAT) Program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis. The testing laboratory firm must be independent of the asbestos contractor and must have no employee or employer relationship which could constitute a conflict of interest.

1.3.12 Landfill Approval

Submit written evidence that the landfill is approved for asbestos disposal by the U.S. Environmental Protection Agency and state and local regulatory agencies. Within three working days after delivery, submit detailed delivery tickets, prepared, signed, and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill. Submit a copy of the waste shipment records within one day of the shipment leaving the project site.

1.3.13 Transporter Certification

Submit written evidence that the transporter is approved to transport asbestos waste in accordance with the DOT requirements of 49 CFR 171, 49 CFR 172 and 49 CFR 173 as well as registration requirements of 49 CFR 107 and all other State and local regulatory agency requirements.

1.3.14 Medical Certification

Provide a written certification for each worker and supervisor, signed by a licensed physician indicating that the worker and supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1926.103 as prescribed by law.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Amended Water; G, RO

Safety Data Sheets (SDS) for All Materials; G, RO

Respirators; G, RO

Local Exhaust Equipment; G, RO

Pressure Differential Automatic Recording Instrument; G, RO

Vacuums; G, RO

Glovebags; G, RO

SD-06 Test Reports

Air Sampling Results; G, RO

Pressure Differential Recordings for Local Exhaust System; G, RO

Clearance Sampling; G, RO

SD-07 Certificates

Employee Training; G, RO

Notifications; G, RO

Respiratory Protection Program; G, RO

Asbestos Hazard Abatement Plan; G, RO

Testing Laboratory; G, RO

Landfill Approval; G, RO

Delivery Tickets; G, RO

Waste Shipment Records; G, RO

Transporter Certification; G, RO

Medical Certification; G, RO

Private Qualified Person Documentation; G, RO

Designated Competent Person; G, RO

Worker's License; G, RO

Contractor's License; G, RO

Equipment Used to Contain Airborne Asbestos Fibers; G, RO

Water Filtration Equipment; G, RO

Vacuums; G, RO

Ventilation Systems; G, RO

SD-11 Closeout Submittals

Permits; G, RO

Notifications; G, RO

Respirator Program Records; G, RO

Rental Equipment; G, RO

1.5 QUALITY ASSURANCE

1.5.1 Private Qualified Person Documentation

Submit the name, address, and telephone number of the Private Qualified Person (PQP) selected to direct monitoring , and documented evidence that the PQP has successfully completed training in and is accredited and where required is certified as, a Building Inspector, Contractor/Supervisor Abatement Worker, and Asbestos Project Designer as described by 40 CFR 763

and has successfully completed the National Institute of Occupational Safety and Health (NIOSH) 582 course "Sampling and Evaluating Airborne Asbestos Dust" or equivalent. The PQP must be appropriately licensed in the State of Colorado as a Project air monitoring specialist. The PQP and the asbestos contractor must not have an employee/employer relationship or financial relationship which could constitute a conflict of interest. The PQP must be a first tier subcontractor.

1.5.2 Designated Competent Person Documentation

The Designated Competent Person must be experienced in the administration and supervision of asbestos abatement projects including exposure assessment and monitoring, work practices, abatement methods, protective measures for personnel, setting up and inspecting asbestos abatement work areas, evaluating the integrity of containment barriers, placement and operation of local exhaust systems, ACM generated waste containment and disposal procedures, decontamination units installation and maintenance requirements, site safety and health requirements, notification of other employees onsite. The Designated Competent Person must be on-site at all times when asbestos abatement activities are underway. Submit training certification and a current State of Colorado Asbestos Contractor's and Supervisor's License. Submit evidence that the Designated Competent Person has a minimum of 2 years of on-the-job asbestos abatement experience relevant to OSHA designated competent person requirements. The Designated Competent Person must be a first tier subcontractor.

1.5.3 Worker's License

Submit documentation that workers meet the requirements of 29 CFR 1926.1101, 40 CFR 61-SUBPART M and have a current State of Colorado Asbestos Workers License/certification.

1.5.4 Contractor's License

Submit a copy of the asbestos contractor's license issued by the State of Colorado.

1.5.5 Air Sampling Results

Complete fiber counting and provide results to the PQP for review within 16 hours of the "time off" of the sample pump. Notify the Contracting Officer immediately of any airborne levels of asbestos fibers in excess of the acceptable limits. Submit sampling results to the Contracting Officer and the affected Contractor employees where required by law within three working days, signed by the testing laboratory employee performing air sampling, the employee that analyzed the sample, and the PQP. Notify the Contractor and the Contracting Officer immediately of any variance in the pressure differential which could cause adjacent unsealed areas to have asbestos fiber concentrations in excess of 0.01 fibers per cubic centimeter or background whichever is higher. In no circumstance must levels exceed 0.1 fibers per cubic centimeter.

1.5.6 Pressure Differential Recordings for Local Exhaust System

Provide a local exhaust system that creates a negative pressure of at least 0.02 inches of water relative to the pressure external to the enclosure and operate it continuously, 24-hours a day, until the temporary enclosure of the asbestos control area is removed. Submit pressure differential recordings for each work day to the PQP for review and to the Contracting

Officer within 24-hours from the end of each work day.

1.5.7 Preconstruction Conference

Conduct a safety preconstruction conference to discuss the details of the Asbestos Hazard Abatement Plan, Accident Prevention Plan (APP) including the AHAs required in specification Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS. The safety preconstruction conference must include the Contractor and their Designated Competent Person, and Project Supervisor and the Contracting Officer. Deficiencies in the APP will be discussed. Onsite work must not begin until the APP has been accepted.

1.6 SECURITY

Barriers to prevent entry of unauthorized persons must be provided for each regulated area. A log book must be kept documenting entry into and out of the regulated area. Entry into regulated areas must only be by personnel authorized by the Contractor and the Contracting Officer. Personnel authorized to enter regulated areas must be trained, medically evaluated, and wear the required personal protective equipment.

1.7 EQUIPMENT

1.7.1 Rental Equipment

Provide a copy of the written notification to the rental company concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.

PART 2 PRODUCTS

2.1 DUCT TAPE

Industrial grade duct tape of appropriate widths suitable for bonding sheet plastic and disposal container.

2.2 DISPOSAL CONTAINERS

Leak-tight (defined as solids, liquids, or dust that cannot escape or spill out) disposal containers must be provided for ACM wastes as required by 29 CFR 1926.1101. Disposal containers can be in the form of:

a. Disposal Bags

b. Fiberboard Drums

c. Cardboard Boxes

2.3 SHEET PLASTIC

Sheet plastic must be polyethylene of 6 mil minimum thickness and must be provided in the largest sheet size necessary to minimize seams. Film must conform to ASTM D4397.

2.4 LEAK-TIGHT WRAPPING

Two layers of 6 mil minimum thick polyethylene sheet stock must be used for the containment of removed asbestos-containing components or materials such as large tanks, boilers, insulated pipe segments and other

materials. Upon placement of the ACM component or material, each layer must be individually leak-tight sealed with duct tape.

2.5 VIEWING INSPECTION WINDOW

Where feasible, a minimum of one clear, 1/8 inch thick, acrylic sheet, 18 by 24 inches, must be installed as a viewing inspection window at eye level on a wall in each containment enclosure. The windows must be sealed leak-tight with industrial grade duct tape.

2.6 WETTING AGENTS

Removal encapsulant (a penetrating encapsulant) must be provided when conducting removal abatement activities that require a longer removal time or are subject to rapid evaporation of amended water. The removal encapsulant must be capable of wetting the ACM and retarding fiber release during disturbance of the ACM greater than or equal to that provided by amended water.

PART 3 EXECUTION

3.1 EQUIPMENT

Provide the Contracting Officer or the Contracting Officer's Representative, with at least two complete sets of personal protective equipment as required for entry to and inspection of the asbestos control area. Provide equivalent training to the Contracting Officer or a designated representative as provided to Contractor employees in the use of the required personal protective equipment. Provide manufacturer's certificate of compliance for all equipment used to contain airborne asbestos fibers.

3.1.1 Air Monitoring Equipment

The Contractor's PQP must approve air monitoring equipment. The equipment must include, but must not be limited to:

a. High-volume sampling pumps that can be calibrated and operated at a constant airflow up to 16 liters per minute.

b. Low-volume, battery powered, body-attachable, portable personal pumps that can be calibrated to a constant airflow up to approximately 3.5 liters per minute, and a self-contained rechargeable power pack capable of sustaining the calibrated flow rate for a minimum of 10 hours. The pumps must also be equipped with an automatic flow control unit which must maintain a constant flow, even as filter resistance increases due to accumulation of fiber and debris on the filter surface.

c. Single use standard 25 mm diameter cassette, open face, 0.8 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive extension cowl, and shrink bands for personal air sampling.

d. A flow calibrator capable of calibration to within plus or minus 2 percent of reading over a temperature range of minus 4 to plus 140 degrees F and traceable to a NIST primary standard.

3.1.2 Respirators

Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services.

3.1.2.1 Respirators for Handling Asbestos

Provide personnel engaged in cleanup, handling, removal and or demolition of asbestos materials with respiratory protection as indicated in 29 CFR 1926.1101 and 29 CFR 1926.103. Breathing air must comply with CGA G-7.

3.1.3 Exterior Whole Body Protection

3.1.3.1 Outer Protective Clothing

Provide personnel exposed to asbestos with disposable "non-breathable," whole body outer protective clothing, head coverings, gloves, and foot coverings. Provide disposable plastic or rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but must not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape.

3.1.3.2 Work Clothing

Provide cloth work clothes for wear under the outer protective clothing and foot coverings and either dispose of or properly decontaminate them as recommended by the approved Asbestos Hazard Abatement Plan after each use.

3.1.3.3 Personal Decontamination Unit

Provide a temporary, negative pressure unit with a separate decontamination locker room and clean locker room with a shower that complies with 29 CFR 1926.51(f)(4)(ii) through (V) in between and state of Colorado regulations for personnel required to wear whole body protective clothing. Provide two separate lockers for each asbestos worker, one in each locker room. Keep street clothing and street shoes in the clean locker. HEPA vacuum and remove asbestos contaminated disposable protective clothing while still wearing respirators at the boundary of the asbestos work area and seal in impermeable bags or containers for disposal. Do not wear work clothing between home and work. Locate showers between the decontamination locker room and the clean locker room and require that all employees shower before changing into street clothes. Collect used shower water and filter with approved water filtration equipment to remove asbestos contamination. Wastewater filters must be installed in series with the first stage pore size 20 microns and the second stage pore size of 5 microns. Dispose of filters and residue as asbestos waste. Discharge clean water to the sanitary system. Dispose of asbestos contaminated work clothing as asbestos contaminated waste. Keep the floor of the decontamination unit's clean room dry and clean at all times. Proper housekeeping and hygiene requirements must be maintained. Provide soap and towels for showering, washing and drying. Cloth towels provided must be disposed of as ACM waste or must be laundered in accordance with 29 CFR 1926.1101. Physically attach the decontamination units to the asbestos control area. Construct both a personnel decontamination unit and an equipment decontamination unit onto and integral with each asbestos control area.

3.1.3.4 Eye Protection

Provide eye protection that complies with ANSI/ISEA Z87.1 when operations present a potential eye injury hazard. Provide goggles to personnel engaged in asbestos abatement operations when the use of a full face respirator is not required.

3.1.4 Regulated Areas

All Class I, II, and III asbestos work must be conducted within regulated areas. The regulated area must be demarcated to minimize the number of persons within the area and to protect persons outside the area from exposure to airborne asbestos. Control access to regulated areas, ensure that only authorized personnel enter, and verify that Contractor required medical surveillance, training and respiratory protection program requirements are met prior to allowing entrance.

3.1.5 Load-out Unit

Provide a temporary load-out unit that is adjacent and connected to the regulated area and access tunnel as needed. Attach the load-out unit in a leak-tight manner to each regulated area.

3.1.6 Warning Signs and Labels

Provide warning signs at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to the requirements are acceptable

3.1.6.1 Warning Sign

Provide vertical format conforming to 29 CFR 1926.200, and 29 CFR 1926.1101 minimum 20 by 14 inches displaying the following legend in the lower panel:

Legend	Notation
DANGER	one inch Sans Serif Gothic or Block
ASBESTOS	one inch Sans Serif Gothic or Block
MAY CAUSE CANCER	one inch Sans Serif Gothic or Block
CAUSES DAMAGE TO LUNGS	1/4 inch Sans Serif Gothic or Block
AUTHORIZED PERSONNEL ONLY	1/4 inch Sans Serif Gothic or Block

Legend	Notation
WEAR RESPIRATORY PROTECTION AND PROTECTIVE CLOTHING IN THIS AREA	1/4 inch Sans Serif Gothic or Block

Spacing between lines must be at least equal to the height of the upper of any two lines.

3.1.6.2 Warning Labels

Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST AVOID CREATING DUST

3.1.7 Local Exhaust System

Provide a local exhaust system in the asbestos control area in accordance with ASSP Z9.2 and 29 CFR 1926.1101 that will provide at least four air changes per hour inside of the negative pressure enclosure. Local exhaust equipment must be operated 24-hours per day, until the asbestos control area is removed and must be leak proof to the filter and equipped with HEPA filters. Maintain a minimum pressure differential in the control area of minus 0.02 inch of water column relative to adjacent, unsealed areas. Provide continuous 24-hour per day monitoring of the pressure differential with a pressure differential automatic recording instrument. The building ventilation system must not be used as the local exhaust system for the asbestos control area. Filters on exhaust equipment must conform to ASSP Z9.2 and UL 586. Terminate the local exhaust system out of doors and remote from any public access or ventilation system intakes.

3.1.8 Tools

Vacuums must be leak proof to the filter and equipped with HEPA filters. Filters on vacuums must conform to ASSP Z9.2 and UL 586. Do not use power tools to remove asbestos containing materials unless the tool is equipped with effective, integral HEPA filtered exhaust ventilation systems. Remove all residual asbestos from reusable tools prior to storage or reuse. Reusable tools must be thoroughly decontaminated prior to being removed from the regulated areas.

3.1.9 Rental Equipment

If rental equipment is to be used, furnish written notification to the rental agency concerning the intended use of the equipment and the possibility of asbestos contamination of the equipment.

3.1.10 Glovebags

Submit written manufacturers proof that glovebags will not break down under expected temperatures and conditions.

3.1.11 Single Stage Decontamination Area

A decontamination area (equipment room/area) must be provided for Class I work involving less than 25 feet or 10 square feet of TSI or surfacing ACM, and for Class II and Class III asbestos work operations where exposures exceed the PELs or where there is no negative exposure assessment. The equipment room or area must be adjacent to the regulated area for the decontamination of employees, material, and their equipment which could be contaminated with asbestos. The area must be covered by an impermeable drop cloth on the floor or horizontal working surface. The area must be of sufficient size to accommodate cleaning of equipment and removing personal protective equipment without spreading contamination beyond the area.

3.1.12 Decontamination Area Exit Procedures

Ensure that the following procedures are followed:

a. Before leaving the regulated area, remove all gross contamination and debris from work clothing using a HEPA vacuum.

b. Employees must remove their protective clothing in the equipment room and deposit the clothing in labeled impermeable bags or containers for disposal or laundering.

c. Employees must not remove their respirators until showering.

d. Employees must shower prior to entering the clean room. If a shower has not been located between the equipment room and the clean room or the work is performed outdoors, ensure that employees engaged in Class I asbestos jobs: a) Remove asbestos contamination from their work suits in the equipment room or decontamination area using a HEPA vacuum before proceeding to a shower that is not adjacent to the work area; or b) Remove their contaminated work suits in the equipment room, without cleaning worksuits, and proceed to a shower that is not adjacent to the work area.

3.2 WORK PROCEDURE

Perform asbestos related work in accordance with 29 CFR 1926.1101, 40 CFR 61-SUBPART M, state of Colorado regulations and as specified herein. Use wet removal procedures and negative pressure enclosure techniques. Wear and utilize protective clothing and equipment as specified herein. No eating, smoking, drinking, chewing gum, tobacco, or applying cosmeticsis permitted in the asbestos work or control areas. Personnel of other trades not engaged in the removal and demolition of asbestos containing material must not be exposed at any time to airborne concentrations of asbestos unless all the personnel protection and training provisions of this specification are complied with by the trade personnel. Shut down the building heating, ventilating, and air conditioning system, cap the openings to the system, prior to the commencement of asbestos work. Power to the regulated area must be locked-out and tagged in accordance with 29 CFR 1910.147. Disconnect

electrical service when wet removal is performed and provide temporary electrical service with verifiable ground fault circuit interrupter (GFCI) protection prior to the use of any water. All electrical work must be performed by a licensed electrician. Stop abatement work in the regulated area immediately when the airborne total fiber concentration: (1) equals or exceeds 0.01 f/cc, or the pre-abatement concentration, whichever is greater, outside the regulated area; or (2) equals or exceeds 1.0 f/cc inside the regulated area. Correct the condition to the satisfaction of the Contracting Officer, including visual inspection and air sampling. Work must resume only upon notification by the Contracting Officer. Corrective actions must be documented. If an asbestos fiber release or spill occurs outside of the asbestos control area, stop work immediately, correct the condition to the satisfaction of the Contracting Officer including clearance sampling, prior to resumption of work.

3.2.1 Building Ventilation System and Critical Barriers

Building ventilation system supply and return air ducts in a regulated area must be isolated by airtight seals to prevent the spread of contamination throughout the system. The airtight seals must consist of 2 layers of polyethylene. Edges to wall, ceiling and floor surfaces must be sealed with industrial grade duct tape.

a. A Competent Person must supervise the work.

b. For indoor work, critical barriers must be placed over all openings to the regulated area.

c. Impermeable dropcloths must be placed on surfaces beneath all removal activity.

3.2.2 Protection of Existing Work to Remain

Perform work without damage or contamination of adjacent work. Where such work is damaged or contaminated as verified by the Contracting Officer using visual inspection or sample analysis, it must be restored to its original condition or decontaminated by the Contractor at no expense to the Government as deemed appropriate by the Contracting Officer. This includes inadvertent spill of dirt, dust, or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, stop work immediately. Then clean up the spill. When satisfactory visual inspection and air sampling results are obtained from the PQP work may proceed at the discretion of the Contracting Officer.

3.2.3 Asbestos Control Area Requirements

3.2.3.1 Negative Pressure Enclosure

Removal of thermal system insulation require the use of a negative pressure enclosure. Block and seal openings in areas where the release of airborne asbestos fibers can be expected. Establish an asbestos negative pressure enclosure with the use of curtains, portable partitions, or other enclosures in order to prevent the escape of asbestos fibers from the contaminated asbestos work area. Negative pressure enclosure development must include protective covering of uncontaminated walls, and ceilings with a continuous membrane of two layers of minimum 6-mil plastic sheet sealed with tape to prevent water or other damage. Provide two layers of 6-mil plastic sheet over floors and extend a minimum of 12 inches up walls. Seal all joints with tape. Provide local exhaust system in the

asbestos control area. Openings will be allowed in enclosures of asbestos control areas for personnel and equipment entry and exit, the supply and exhaust of air for the local exhaust system and the removal of properly containerized asbestos containing materials. Replace local exhaust system filters as required to maintain the efficiency of the system.

3.2.3.2 Glovebag

If the construction of a negative pressure enclosure is infeasible for the removal of thermal systems insulation, use alternate techniques as indicated in 29 CFR 1926.1101. Establish designated limits for the asbestos regulated area with the use of rope or other continuous barriers, and maintain all other requirements for asbestos control areas. The PQP must conduct personal samples of each worker engaged in asbestos handling (removal, disposal, transport and other associated work) throughout the duration of the project. If the quantity of airborne asbestos fibers monitored at the breathing zone of the workers at any time exceeds background or 0.01 fibers per cubic centimeter whichever is greater, stop work, evacuate personnel in adjacent areas or provide personnel with approved protective equipment at the discretion of the Contracting Officer. If adjacent areas are contaminated as determined by the Contracting Officer, clean the contaminated areas, monitor, and visually inspect the area as specified herein.

3.2.3.3 Regulated Area for Class II Removal

For any Class II removal activities establish designated limits for the asbestos regulated work area with the use of red barrier tape; install critical barriers, splash guards and signs, and maintain all other requirements for asbestos control area except local exhaust. Place impermeable dropcloths on surfaces beneath removal activity extending out 3 feet in all directions. A detached decontamination system may be used. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If workers the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work immediately and correct the situation.

3.2.4 Removal Procedures

Wet asbestos material with a fine spray of amended water during removal, cutting, or other handling so as to reduce the emission of airborne fibers. Remove material and immediately place in 6 mil plastic disposal bags. Remove asbestos containing material in a gradual manner, with continuous application of the amended water or wetting agent in such a manner that no asbestos material is disturbed prior to being adequately wetted. Where unusual circumstances prohibit the use of 6 mil plastic bags, submit an alternate proposal for containment of asbestos fibers to the Contracting Officer for approval. For example, in the case where both piping and insulation are to be removed, the Contractor may elect to wet the insulation, wrap the pipes and insulation in plastic and remove the pipe by sections. Containerize asbestos containing material while wet. Do not allow asbestos material to accumulate or become dry. Lower and otherwise handle asbestos containing material as indicated in 40 CFR 61-SUBPART M.

3.2.4.1 Exposed Pipe Insulation Edges

Contain edges of asbestos insulation to remain that are exposed by a removal operation. Wet and cut the rough ends true and square with sharp tools and then encapsulate the edges with a 1/4 inch thick layer of non-asbestos containing insulating cement troweled to a smooth hard finish. When cement is dry, lag the end with a layer of non-asbestos lagging cloth, overlapping the existing ends by at least 4 inches. When insulating cement and cloth is an impractical method of sealing a raw edge of asbestos, take appropriate steps to seal the raw edges as approved by the Contracting Officer.

3.2.5 Methods of Compliance

3.2.5.1 Mandated Practices

The specific abatement techniques and items identified must be detailed in the Contractor's AHAP. Use the following engineering controls and work practices in all operations, regardless of the levels of exposure:

a. Vacuum cleaners equipped with HEPA filters.

b. Wet methods or wetting agents except where it can be demonstrated that the use of wet methods is unfeasible due to the creation of electrical hazards, equipment malfunction, and in roofing.

c. Prompt clean-up and disposal.

d. Inspection and repair of polyethylene.

e. Cleaning of equipment and surfaces of containers prior to removing them from the equipment room or area.

3.2.5.2 Control Methods

Use the following control methods:

a. Local exhaust ventilation equipped with HEPA filter;

b. Enclosure or isolation of processes producing asbestos dust;

c. Where the feasible engineering and work practice controls are not sufficient to reduce employee exposure to or below the PELs, use them to reduce employee exposure to the lowest levels attainable and must supplement them by the use of respiratory protection.

3.2.5.3 Unacceptable Practices

The following work practices must not be used:

a. High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air.

b. Compressed air used to remove asbestos containing materials, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.

c. Dry sweeping, shoveling, or other dry clean up.

d. Employee rotation as a means of reducing employee exposure to asbestos.

3.2.6 Class I Work Procedures

In addition to requirements of paragraphs MANDATED PRACTICES and CONTROL METHODS, the following engineering controls and work practices must be used:

a. A Competent Person must supervise the installation and operation of the control methods.

b. For jobs involving the removal of more than 25 feet or 10 square feet of TSI or surfacing material, place critical barriers over all openings to the regulated area.

c. HVAC systems must be isolated in the regulated area by sealing with a double layer of plastic or air-tight rigid covers.

d. Impermeable dropcloths (6 mil or greater thickness) must be placed on surfaces beneath all removal activity.

e. Where a negative exposure assessment has not been provided or where exposure monitoring shows the PEL was exceeded, the regulated area must be ventilated with a HEPA unit and employees must use PPE.

3.2.7 Specific Control Methods for Class I Work

Use Class I work procedures, control methods and removal methods for the following ACM:

Thermal System Insulation and Mudded Pipe Fittings

3.2.7.1 Negative Pressure Enclosure (NPE) System

The system must provide at least four air changes per hour inside the containment. The local exhaust unit equipment must be operated 24-hours per day until the containment is removed. The NPE must be smoke tested for leaks at the beginning of each shift and be sufficient to maintain a minimum pressure differential of minus 0.02 inch of water column relative to adjacent, unsealed areas. Pressure differential must be monitored continuously, 24-hours per day, with an automatic manometric recording instrument and Records must be provided daily on the same day collected to the Contracting Officer. The Contracting Officer must be notified immediately if the pressure differential falls below the prescribed minimum. The building ventilation system must not be used as the local exhaust system for the regulated area. The NPE must terminate outdoors unless an alternate arrangement is allowed by the Contracting Officer. All filters used must be new at the beginning of the project and must be periodically changed as necessary and disposed of as ACM waste.

3.2.7.2 Glovebag Systems

Glovebags must be used without modification, smoke-tested for leaks, and completely cover the circumference of pipe or other structures where the

work is to be done. Glovebags must be used only once and must not be moved. Glovebags must not be used on surfaces that have temperatures exceeding 150 degrees F. Prior to disposal, glovebags must be collapsed using a HEPA vacuum. Before beginning the operation, loose and friable material adjacent to the glovebag operation must be wrapped and sealed in 2 layers of plastic or otherwise rendered intact. At least two persons must perform glovebag removal. Asbestos regulated work areas must be established for glovebag abatement. Designated boundary limits for the asbestos work must be established with rope or other continuous barriers and all other requirements for asbestos control areas must be maintained, including area signage and boundary warning tape.

a. Attach HEPA vacuum systems to the bag to prevent collapse during removal of ACM.

b. The negative pressure glove boxes must be fitted with gloved apertures and a bagging outlet and constructed with rigid sides from metal or other material which can withstand the weight of the ACM and water used during removal. A negative pressure must be created in the system using a HEPA filtration system. The box must be smoke tested for leaks prior to each use.

3.2.7.3 Mini-Enclosure

Mini-containment (small walk-in enclosure) to accommodate no more than two persons, may be used if the disturbance or removal can be completely contained by the enclosure. The mini-enclosure must be inspected for leaks and smoke tested before each use. Air movement must be directed away from the employee's breathing zone within the mini-enclosure.

3.2.7.4 Wrap and Cut Operation

Prior to cutting pipe, the asbestos-containing insulation must be wrapped with polyethylene and securely sealed with duct tape to prevent asbestos becoming airborne as a result of the cutting process. The following steps must be taken: install glovebag, strip back sections to be cut 6 inches from point of cut, and cut pipe into manageable sections.

3.2.7.5 Class I Removal Method

Class I ACM must be removed using a control method described above. Prepare work area as previously specified. Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area. Spread one layer of 6-mil seamless plastic sheeting on the floor below the work area. Remove ACM thermal system insulation and mudded pipe fittings using mechanical means and wet methods and immediately place into 6-mil thickness disposal bag. Continue wet cleaning until surfaces are free of visible debris. Bag all asbestos debris which has fallen to the floor as asbestos-containing debris. Place all debris in plastic disposal bags of 6-mil minimum thickness. Once the material is in the disposal bag, apply additional water as needed to achieve "adequately wet" conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duck tape to seal the bag, wash to remove any visible contamination and place into a second 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Lower and otherwise handle asbestos containing materials as indicated in 40 CFR 61-SUBPART M. Conduct area monitoring of airborne fibers during

the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the quantity of airborne asbestos fibers monitored at the breathing zone of the workers or the designated limits at any time exceeds background or 0.01 fibers per cubic centimeter, whichever is greater, stop work, and immediately correct the situation.

3.2.8 Class II Work Procedures

In addition to the requirements of paragraphs MANDATED PRACTICES and CONTROL METHODS, the following engineering controls and work practices must be used:

a. A Competent Person must supervise the work.

b. For indoor work, critical barriers must be placed over all openings to the regulated area.

c. Impermeable dropcloths must be placed on surfaces beneath all removal activity.

3.2.9 Air Sampling

Perform sampling of airborne concentrations of asbestos fibers in accordance with 29 CFR 1926.1101, the Contractor's air monitoring plan and as specified herein. Sampling performed in accordance with 29 CFR 1926.1101 must be performed by the PQP. Sampling performed for environmental and quality control reasons must be performed by the PQP. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Monitoring may be duplicated by the Government at the discretion of the Contracting Officer. If the air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate. Results of breathing zone samples must be posted at the job site and made available to the Contracting Officer. Submit all documentation regarding initial exposure assessments, negative exposure assessments, and air-monitoring results.

3.2.9.1 Sampling Prior to Asbestos Work

Provide area air sampling and establish the baseline one day prior to the masking and sealing operations for each removal site. Establish the background by performing area sampling in similar but uncontaminated sites in the building.

3.2.9.2 Sampling During Asbestos Work

The PQP must provide personal and area sampling as indicated in 29 CFR 1926.1101 and governing environmental regulations. Breathing zone samples must be taken for at least 25 percent of the workers in each shift, or a minimum of two, whichever is greater. Air sample fiber counting must be completed and results provided within 24-hours (breathing zone samples), and 48 hours (environmental/clearance monitoring) after completion of a sampling period. In addition, provided the same type of work is being performed, provide area sampling at least once every work shift close to the work inside the enclosure, outside the clean room entrance to the enclosure, and at the exhaust opening of the local exhaust system. If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fibers per cubic centimeter, whichever is

greater, stop all work, correct the condition(s) causing the increase, and notify the Contracting Officer immediately. The written results must be signed by testing laboratory analyst, testing laboratory principal and the Contractor's PQP. The air sampling results must be documented on a Contractor's daily air monitoring log.

3.2.9.3 Final Clearance Requirements, NIOSH PCM Method

For PCM sampling and analysis using NIOSH NMAM Method 7400, the fiber concentration inside the abated regulated area, for each airborne sample, must be less than 0.01 f/cc. The abatement inside the regulated area is considered complete when every PCM final clearance sample is below the clearance limit. If any sample result is greater than 0.01 total f/cc, the asbestos fiber concentration (asbestos f/cc) must be confirmed from that same filter using NIOSH NMAM Method 7402 (TEM) at Contractor's expense. If any confirmation sample result is greater than 0.01 asbestos f/cc, abatement is incomplete and cleaning must be repeated at the Contractor's expense. Upon completion of any required recleaning, resampling with results to meet the above clearance criteria must be done at the Contractor's expense.

3.2.9.4 Sampling After Final Clean-Up (Clearance Sampling)

Provide area sampling of asbestos fibers and establish an airborne asbestos concentration of less than 0.01 fibers per cubic centimeter after final clean-up but before removal of the enclosure or the asbestos work control area. After final cleanup and the asbestos control area is dry but prior to clearance sampling, the PQP must perform a visual inspection to ensure that the asbestos control and work area is free of any accumulations of dirt, dust, or debris. Prepare a written report signed and dated by the PQP documenting that the asbestos control area is free of dust, dirt, and debris and all waste has been removed. The asbestos fiber counts from these samples must be less than 0.01 fibers per cubic centimeter or be not greater than the background, whichever is greater. Should any of the final samples indicate a higher value take appropriate actions to re-clean the area and repeat the sampling and analysis at the Contractor's expense.

3.2.9.5 Air Clearance Failure

If clearance sampling results fail to meet the final clearance requirements, pay all costs associated with the required recleaning, resampling, and analysis, until final clearance requirements are met.

3.2.10 Site Inspection

While performing asbestos engineering control work, the Contractor must be subject to on-site inspection by the Contracting Officer who may be assisted by or represented by safety or industrial hygiene personnel. If the work is found to be in violation of this specification, the Contracting Officer or his representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the violation must be at the Contractor's expense.

3.3 CLEAN-UP AND DISPOSAL

3.3.1 Housekeeping

Essential parts of asbestos dust control are housekeeping and clean-up procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. When asbestos removal is complete, all asbestos waste is removed from the work-site, and final clean-up is completed, the Contracting Officer will attest that the area is safe before the signs can be removed. Reestablish HVAC mechanical, and electrical systems in proper working order. The Contracting Officer will visually inspect all surfaces within the enclosure for residual material or accumulated dust or debris. The Contractor must re-clean all areas showing dust or residual materials. If re-cleaning is required, air sample and establish an acceptable asbestos airborne concentration after re-cleaning. The Contracting Officer must agree that the area is safe in writing before unrestricted entry will be permitted. The Government must have the option to perform monitoring to determine if the areas are safe before entry is permitted.

3.3.2 Responsibility for Materials

All waste materials, except as specified otherwise, become the responsibility of the Contractor and must be disposed of as specified in applicable local, State, and Federal regulations and herein.

3.3.3 Disposal of Asbestos

3.3.3.1 Procedure for Disposal

Coordinate all waste disposal manifests with the Contracting Officer and facility environmental POC. Collect asbestos waste, contaminated waste water filters, asbestos contaminated water, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing which may produce airborne concentrations of asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g. double plastic bags 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-SUBPART M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 6 mils thick bags with the approved warnings and DOT labeling preprinted on the bag. Clearly indicate on the outside of each container the name of the waste generator and the location at which the waste was generated. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at an Environmental Protection Agency (EPA) or State-approved asbestos landfill off Government property. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be assigned by the Contracting Officer or his authorized representative. Comply with 40 CFR 61-SUBPART M, State, regional, and local standards for hauling and disposal. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or

damaged. Damaged bags must remain in the drum and the entire contaminated drum must be buried. Uncontaminated drums may be recycled. Workers unloading the sealed drums must wear appropriate respirators and personal protective equipment when handling asbestos materials at the disposal site.

-- End of Section --

165 South Union Boulevard
Suite 310
Lakewood, CO 80228
303.988.2585
Fax 303.988.2583

Clayton GROUP SERVICES

28 March 2005

Mr. Chad Callan, CHMM
Base Toxics Program Manager
460th Civil Engineering Squadron / CEV
660 South Aspen Street, Stop 86
Buckley Air Force Base, Colorado 80011-9551

Clayton Project No. 90-04152.00

Subject: **Assessment of Suspect Asbestos-Containing Building Materials Building 417 – Buckley Air Force Base, Colorado**

Dear Mr. Callan:

On 24 January 2005, Mr. Mike Dubois, a state-licensed asbestos building inspector, performed an assessment of the suspect asbestos-containing building materials (ACBM) within Bldg 417, Buckley Air Force Base (AFB), Colorado. This work was performed under Order Number FA2543-05-F-0014 issued by the 460th Contracting Squadron utilizing General Services Administration (GSA) contract no. GS-10F-0307K.

DESCRIPTION OF ASSESSMENT

Purpose of Assessment

It is Clayton's understanding that the purpose for this assessment was to identify and assess suspect ACBM within the facility in preparation for the development of a written Maintenance Plan specific for Bldg 417. As necessary, the development of the Maintenance Plan is included within the scope of work for this project.

Building Inspection, Material Sampling, And Analysis

All accessible areas within the facility were inspected for suspect ACBM including thermal systems insulation, surfacing materials, and miscellaneous materials (e.g., floor coverings, mastics, and gasket material). When materials suspected of containing asbestos were located, representative samples were collected from each homogeneous material.

If hidden suspect building materials are encountered during routine operations, renovations or other activities in the facilities, sampling and analysis of these materials for the presence of asbestos should be done prior to disturbing suspect materials.

Clayton's assessors utilized hand-held core borers, utility knives, hammers and chisels, and other such hand tools to collect samples. Suspect material was wetted before sampling occurred. When necessary, suspect friable material was sampled while wetting the material. Damaged sampling areas were patched with tape, or filled with caulking. Unique identification numbers were applied on suspect materials that were sampled.

Areas with similar-appearing materials were identified and recorded. Homogeneous areas (to the extent possible) were identified and recorded within each facility. Homogeneous materials are based upon the functional space and similarity of materials. The Clayton inspector obtained digital photographs of suspect materials that were sampled.

The inspector recorded information regarding the condition and location of each sampled material on various field forms. In accordance with inspection protocols, if any one sample within one homogeneous area was confirmed as positive, the homogeneous area was considered positive in its entirety.

Samples were analyzed for asbestos content using polarized light microscopy (PLM) following the US EPA Method EPA-600/M4-82-020, for determining asbestos fibers in bulk materials. Clayton's laboratories are accredited for asbestos analysis by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). As necessary, additional analysis was performed on vinyl floor tile by transmission electron microscopy as outlined in Title 40, Code of Federal Regulations (CFR), Part 763 (Appendix A to Subpart E).

RESULTS

Samples Collected

A total of three (3) samples of various building materials were collected from various locations within the facility.

Assessment Results

The results of the inspection and assessment of this facility is provided as tabs to this report. As appropriate, the following seven (7) tabs are provided as follows:

- Tab 1 presents a facility summary of asbestos sample analysis results, including detailed information regarding suspect ACBM.
- Tab 2 presents a summary of ACM assigned an AF Priority of 1 or 2, based on the calculations presented in the afore-mentioned USAFOEHL Report.
- Tab 3 provides facility diagrams showing sampling locations of all samples.
- Tab 4 presents photo documentation by facility of the homogenous areas of confirmed ACBM that were identified during this survey.
- Tab 5 presents the analytical results for each facility from which the samples were collected during this survey.
- Tab 6 presents the Chain of Custody/Sample Submission Forms used for each facility during this survey.
- As appropriate for this facility, Tab 7 presents the Facility Maintenance Plan.

APPLICABLE REGULATIONS AND GUIDELINES

In the event that ACBM is uncovered at some future date, the following regulations and guidelines may apply.

USEPA National Emissions Standard for Hazardous Air Pollutants (NESHAP)
40 CFR 61 (Subparts A & M)

The USEPA asbestos NESHAP regulations apply to certain demolition and renovation projects in facilities containing ACBM. The NESHAP rule requires that all friable ACBM and some categories of non-friable ACBM be removed before a building is demolished, and may require localized removal before or as part of a renovation. For renovation projects where friable ACBM will be disturbed, the NESHAP rule requires appropriate work practices or procedures for the control of emissions. The following USEPA NESHAP definitions of ACBM are important in interpreting which NESHAP requirements may apply to your building:

- *Asbestos-containing material (ACM):* any material that contains greater than one percent asbestos as determined using PLM analysis.
- *Friable asbestos-containing material:* any material containing greater than one percent asbestos, determined using PLM analysis, that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

- *Category I nonfriable asbestos-containing material*: asbestos-containing packing material, gaskets, resilient floor covering, and asphalt roofing products containing greater than one percent asbestos as determined using PLM.

- *Category II nonfriable asbestos-containing material:* any material excluding Category I nonfriable ACM, containing greater than 1 percent asbestos as determined using PLM that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

- *Regulated asbestos-containing material:* (*RACM*): (1) friable ACM, (2) Category I non-friable ACM that has become friable, (3) Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading, or (4) Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the materials in the course of demolition or renovation operations regulated by NESHAP.

Asbestos-containing materials need not be removed before demolition if:

- It is Category I non-friable ACM that is not in poor condition and is not friable.

- It is on a facility component that is enclosed in concrete or other similarly hard material and is adequately wet whenever exposed during demolition.

- It was discovered after demolition began, and as a result, cannot be safely removed. If not removed, the material must be kept wet until disposal.

- It is Category II non-friable ACM and the probability is low that the material will become crumbled, pulverized, or reduced to powder during demolition.

- Its is determined that the facility in question is structurally sound prior to demolition and any friable ACM cannot safely be removed from the facility.

NESHAP also requires that the USEPA or the state (if the state has been delegated authority under NESHAP) be notified before a building is demolished, and/or before renovations impacting RACM begin.

<u>Occupational Safety and Health Administration (OSHA)
29 CFR 1910.1001 & 29 CFR 1926.1101</u>

OSHA regulates employee exposure to asbestos. The OSHA asbestos standards for general industry and for construction mandate a permissible exposure limit (PEL) of 0.1

fibers (equal to or longer than 5 micrometers) per cubic centimeter of air (fibers/cc) determined as an 8-hour, time-weighted average (TWA) and an excursion limit of 1 fiber/cc as a 30 minute TWA.

For asbestos removal or renovation involving ACM, the construction asbestos standard (29 CFR 1926.1101) requires that specific procedures be followed, including enclosure of the work area, to control asbestos exposure of building occupants, as well as employees involved in abatement or renovation activities.

If ACM is managed in place, the OSHA general industry asbestos standard (29 CFR 1910.1001) applies to employees who may contact or disturb ACM during their work shift. In accordance with this standard, employees such as maintenance and custodial workers must be informed of the presence and location of ACM and/or presumed ACM (PACM). Warning signs or labels must be used to identify ACM and/or PACM in the facility.

Colorado Department of health and the Environment (CDPHE)
Colorado Regulation 8, Part B

The Colorado Air Quality Control Commission has promulgated regulations pertaining to asbestos activities as outlined in Colorado Regulation 8, Part B. Colorado Regulation 8, Part B generally provides protection to Colorado citizens from exposure to asbestos, a Class A carcinogen, caused by improper abatements due to inadequate training of asbestos workers, supervisors, inspectors, management planners and project designers.

Air Force Asbestos Guidance for Rating and Assessing Damage and Exposure (GRADE) System – USAFOEHL Report 86-072EH0021HGA

The GRADE System provides a scoring and rating procedure for assessing damage and potential for damage and resultant potential exposure conditions associated with the presence of sprayed-on, trowelled-on, or damaged friable asbestos-containing material (ACM), and is intended to be used as an Air Force-wide asbestos abatement prioritization tool.

At the time of this survey, no material within the facility required the application of the GRADE System.

Thank you for allowing Clayton to support both Buckley Air Force Base and the United States Air Force. It has been a pleasure working with all involved in this project.

Sincerely,

#202

For Mike Dubois
CO Asbestos Building Inspector #805

Reviewed by:

T. Mark Suggs, OHST, REM
Program Manager

TMS/tms

7 Tabs:

1. Summary of Asbestos Sample Analysis Results
2. GRADE 1 & 2 Summary for Asbestos-Containing Materials
3. Sample Location Diagrams
4. Photographs of Confirmed Asbestos-Containing Materials
5. Analytical Results
6. Chains of Custody/Sample Submission Forms
7. Facility Maintenance Plan (as appropriate)

Table of Contents

Clayton Project No. 90-04152.00

Summary of Asbestos Sample Analysis Results 1

GRADE 1 & 2 Summary for Asbestos-Containing Materials 2

Sample Location Diagrams 3

Photographs of Confirmed Asbestos-Containing Materials 4

Analytical Results 5

Chains of Custody/Sample Submission Forms 6

Facility Maintenance Plan 7

8

TAB 1

Summary of Asbestos Sample Results

Regulated Building Materials Management System

Summary of Asbestos Sample Analysis Results

Sample Number	Layer	Material Type	Sample Description	Layer Description	Area	Room	Asbestos Containg Material and Content	Condition	AF Priority	Comments
417-B007-012405		TSI	black insulation	Gray and yellow fibrous material	Storage	NA	%	Friable	0	
							%			
							%			
417-B008-012405		Surface Material	white paint & skim coat	Off-white paint on tan and gray gritty material	Storage	NA	%	Non-Friable	0	
							%			
							%			
417-B009-012405	1	Misc.	black covebase & almond mastic	Black vinyl	Storage	NA	%	Non-Friable	0	
							%			
							%			
	2	Misc.	black covebase & almond mastic	Yellow soft mastic	Storage	NA	%	Non-Friable	0	
							%			
							%			

FOOTNOTE: If applicable, the percent asbestos identified in this printout reports the three major asbestos types identified in the sample.

NOTES:
- The limit of detection by PLM is 0.25%.
- 0% with identified asbestos type indicates "trace" quantities with no point count data available; material should be treated as ACM.

02 82 00AT1

TAB 2

GRADE 1 & 2 Summary for Asbestos-Containing Materials

GRADE 1 & 2 Summary for Asbestos-Containing Materials

At the time of this survey, no materials within this building warranted the assignment of an Air Force Priority of 1 or 2 as specified in USAFOEHL Report 86-072EH0021HGA.

TAB 3

Sample Location Diagrams

CAD Drawings

The CAD drawings for this building were inadvertently deleted. The drawings will be re-accomplished and provided during Clayton Project No. 90-04152.01.

TAB 4

Photographs of Confirmed Asbestos-Containing Materials

Photographs of Confirmed Asbestos-Containing Materials

No photographs are provided in this tab; analytical results for samples collected during this survey for this building were negative for asbestos.

TAB 5

Analytical Results

Clayton GROUP SERVICES
4636 E. Marginal Way So. Suite 215
Seattle, WA 98134
(206) 763-7364

ASBESTOS BULK SAMPLE DATA

NVLAP LAB CODE #101106-0

Accredited Laboratory

Supplemental Report

Log #: 37815
Priority: Regular B
Project #: 90-04152.00
Number of Samples: 9

Client Name: **Clayton Group Services**

Contact:

Job Location: **Buckley AFB, Building 416 and 417**

PO/Job#:

SAMPLE #: **416-B-001**

LAB #: 37815.1

SOURCE: **TSI**

LOCATION: **None Given**

MATERIAL DESCRIPTION: **HOMOGENEOUS**
Off-white fibrous compressed powdery material

RESULTS:

No Asbestos Detected

ASBESTOS TYPE	PERCENT

OTHER FIBERS	%
Cellulose	12
Synthetic	8

OTHER MATERIALS	%
Filler & Binder	80

Note:

SAMPLE #: **416-B-002**

LAB #: 37815.2

SOURCE: **Sealant**

LOCATION: **None Given**

MATERIAL DESCRIPTION: **HOMOGENEOUS**
Gray flexible material

RESULTS:

No Asbestos Detected

ASBESTOS TYPE	PERCENT

OTHER FIBERS	%

OTHER MATERIALS	%
Filler & Binder	100

Note:

SAMPLE #: **416-B-003**

LAB #: 37815.3

SOURCE: **TSI**

LOCATION: **None Given**

MATERIAL DESCRIPTION: **HOMOGENEOUS**
Off-white fibrous compressed powdery material

RESULTS:

No Asbestos Detected

ASBESTOS TYPE	PERCENT

OTHER FIBERS	%
Cellulose	13
Synthetic	7

OTHER MATERIALS	%
Filler & Binder	80

Note:

SAMPLED BY: Mike DuBois DATE: 1/24/2005

COMPANY: Clayton Group Services

RECEIVED BY: Ginnie Psachos DATE: 1/25/2005

ANALYZED BY: Rachel Melgoza DATE: 1/26/2005

Tracy Perkins

Tracy Perkins or other NVLAP Approved Signatory

Clayton is accredited by NIST/NVLAP. Accreditation by NVLAP does not indicate endorsement by NVLAP or any other government agency. All bulk samples are analyzed in accordance with method EPA/600/M4-82-020 (December 1982). Analyses are cross-checked through inter and intra laboratory quality assurance programs for verification. The percent values reported above are based on calibrated visual estimates by volume unless verification by Point Counting is indicated. Test results reported relate only to the samples submitted by the client to Clayton. Trace amounts of asbestos could possibly be missed by PLM, therefore negative results cannot be guaranteed. This report shall not be reproduced except in [illegible] Clayton Group Services permission. Error Rates: Chrysotile, Amosite and Crocidolite asbestos: Qualitative-.03, Quantitative-.12 / Tremolite, Actinolite and Anthophyllite asbestos: Qualitative-.03, Quantitative-.02 A trace amount of asbestos is defined as one to two fibers found [illegible] Chrysotile asbestos found in this amount will be reported as "Trace".

Clayton GROUP SERVICES
4636 E. Marginal Way So. Suite 215
Seattle, WA 98134
(206) 763-7364

ASBESTOS BULK SAMPLE DATA

NVLAP LAB CODE #101106-0

Accredited Laboratory

Supplemental Report

Log #: 37815
Priority: Regular B
Project #: 90-04152.00
Number of Samples: 9

Client Name: **Clayton Group Services**

Contact:

Job Location: **Buckley AFB, Building 416 and 417**

PO/Job#:

SAMPLE #: **416-B-004**

LAB #: 37815.4

SOURCE: **CMU Block**

LOCATION: **None Given**

MATERIAL DESCRIPTION: **LAYERED**

Off-white and peach-colored paint layers on off-white powder

RESULTS:

Layers Homogenized for Analysis

No Asbestos Detected

ASBESTOS TYPE	PERCENT

Note:

OTHER FIBERS	%
Cellulose	Trace

OTHER MATERIALS	%
Filler & Binder	20
Paint	80

SAMPLE #: **416-B-005**

LAB #: 37815.5

SOURCE: **Mortar**

LOCATION: **None Given**

MATERIAL DESCRIPTION: **LAYERED**

Peach-colored paint on gray gritty material

RESULTS:

Layers Homogenized for Analysis

No Asbestos Detected

ASBESTOS TYPE	PERCENT

Note:

OTHER FIBERS	%
Cellulose	Trace
Synthetic	Trace

OTHER MATERIALS	%
Aggregate	60
Filler & Binder	30
Paint	10

SAMPLE #: **416-B-006**

LAB #: 37815.6

SOURCE: **Sealant**

LOCATION: **None Given**

MATERIAL DESCRIPTION: **LAYERED**

Peach-colored paint on gray sticky putty

RESULTS:

Layers Homogenized for Analysis

No Asbestos Detected

ASBESTOS TYPE	PERCENT

Note:

OTHER FIBERS	%
Cellulose	Trace

OTHER MATERIALS	%
Filler & Binder	90
Paint	10

SAMPLED BY: Mike DuBois DATE: 1/24/2005

COMPANY: Clayton Group Services

RECEIVED BY: Ginnie Psachos DATE: 1/25/2005

ANALYZED BY: Rachel Melgoza DATE: 1/26/2005

Tracy Perkins

Tracy Perkins or other NVLAP Approved Signatory

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Clayton GROUP SERVICES
4636 E. Marginal Way So. Suite 215
Seattle, WA 98134
(206) 763-7364

ASBESTOS BULK SAMPLE DATA

NVLAP LAB CODE #101106-0

Accredited Laboratory

Supplemental Report

Log #:	**37815**
Priority:	**Regular B**
Project #:	**90-04152.00**
Number of Samples:	**9**

Client Name: **Clayton Group Services** Contact:

Job Location: **Buckley AFB, Building 416 and 417** PO/Job#:

SAMPLE #: **417-B-007**

LAB #: 37815.7

SOURCE: **Batt Insulation (Rockwool)**

LOCATION: **None Given**

MATERIAL DESCRIPTION: **HOMOGENEOUS**

Gray and yellow fibrous material

RESULTS:

No Asbestos Detected

ASBESTOS TYPE	PERCENT

Note:

OTHER FIBERS	%
Mineral Wool	95

OTHER MATERIALS	%
Miscellaneous Particles	5

SAMPLE #: **417-B-008**

LAB #: 37815.8

SOURCE: **CMU Block**

LOCATION: **None Given**

MATERIAL DESCRIPTION: **LAYERED**

Off-white paint on tan and gray gritty material

RESULTS:

Layers Homogenized for Analysis

No Asbestos Detected

ASBESTOS TYPE	PERCENT

Note:

OTHER FIBERS	%
Cellulose	Trace

OTHER MATERIALS	%
Aggregate	60
Filler & Binder	35
Paint	5

LAYERED SAMPLE: NESHAP and AHERA regulations require layers be analyzed and reported separately.

SAMPLE #: **417-B-009**

LAB #: 37815.9A

SOURCE: **Cove Base**

LOCATION: **None Given**

MATERIAL DESCRIPTION:

Black vinyl

LAYER 1 RESULTS:

No Asbestos Detected

ASBESTOS TYPE	PERCENT

Note:

OTHER FIBERS	%

OTHER MATERIALS	%
Vinyl Filler and Binder	100

SAMPLED BY: Mike DuBois DATE: 1/24/2005

COMPANY: Clayton Group Services

RECEIVED BY: Ginnie Psachos DATE: 1/25/2005

ANALYZED BY: Rachel Melgoza DATE: 1/26/2005

Tracy Perkins

Tracy Perkins or other NVLAP Approved Signatory

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Clayton GROUP SERVICES
4636 E. Marginal Way So. Suite 215
Seattle, WA 98134
(206) 763-7364

ASBESTOS BULK SAMPLE DATA

NVLAP LAB CODE #101106-0

Accredited Laboratory

Supplemental Report

Log #:	**37815**
Priority:	**Regular B**
Project #:	**90-04152.00**
Number of Samples:	**9**

Client Name: **Clayton Group Services**

Contact:

Job Location: **Buckley AFB, Building 416 and 417**

PO/Job#:

SAMPLE #: **417-B-009**

LAB #: 37815.9B

SOURCE: **Mastic**

LOCATION: **None Given**

MATERIAL DESCRIPTION:

Yellow soft mastic

LAYER 2 RESULTS:

No Asbestos Detected

ASBESTOS TYPE	PERCENT

OTHER FIBERS	%
Cellulose	1

OTHER MATERIALS	%
Filler & Binder	80
Fine Grains	19

Note:

SAMPLED BY: Mike DuBois DATE: 1/24/2005

COMPANY: Clayton Group Services

RECEIVED BY: Ginnie Psachos DATE: 1/25/2005

ANALYZED BY: Rachel Melgoza DATE: 1/26/2005

Tracy Perkins

Tracy Perkins or other NVLAP Approved Signatory

Clayton is accredited by NIST/NVLAP. Accreditation by NVLAP does not indicate endorsement by NVLAP or any other government agency. All bulk samples are analyzed in accordance with method EPA/600/M4-82-020 (December 1982). Analyses are cross-checked through inter and intra laboratory quality assurance programs for verification. The percent values reported above are based on calibrated visual estimates by volume unless verification by Point Counting is indicated. Test results reported relate only to the samples submitted by the client to Clayton. Trace amounts of asbestos could possibly be missed by PLM, therefore negative results cannot be guaranteed. This report shall not be reproduced except in its entirety, without Clayton Group Services permission. Error Rates: Chrysotile, Amosite and Crocidolite asbestos: Qualitative-.03, Quantitative-.12 / Tremolite, Actinolite and Anthophyllite asbestos: Qualitative-.03, Quantitative-.12 A trace amount of asbestos is defined as one to two fibers found [illegible] asbestos found in this amount will be reported as "Trace".

TAB 6

Chains of Custody/Sample Submission Forms

37815 9-Reg PLM

Clayton GROUP SERVICES

REQUEST FOR LABORATORY ANALYTICAL SERVICES

page 1

IMPORTANT: Date results required: ASAP; Rush charges authorized? No; Phone results? No; Fax results? Yes

Special instructions and/or specific regulatory requirements:

1. Analysis: ✓ PLM __ Semi-Ouant TEM
2. Analyze By: ✓ Grouping Until Positive __ All
3. If results <1%, ✓ perform point count
4. Requested Analysis: ✓ Layered __ Composite
5. Turnaround: __ 2-Hour __ 24-Hour ✓ 3-5 Days

Report results to: Project Manager
Clayton Group Services
165 S. Union Blvd, Ste 310
Lakewood, CO 80228

Telephone No. 303.988.2585
Fax No. 303.988.2583

Client Project No. 90-04152.00

Sample No.	Date Sampled	Sample Description	Location	Category	Photo Ref.
416-B-001 HA 1	24 JAN 05	**Asbestos** Comments: 12" DIA. RADIATOR FEED LINE W/WHT. TSI	BLDG. 416 EMERG. LIGHTING GENERATOR ROOM Qnty: 12 ~ ~~8~~ L/Ft.	☐ Damaged/significantly damaged TSI ACM ☐ Damaged friable surfacing ACM ☐ Significantly damaged friable surfacing ACM ☐ Damaged/significantly damaged friable misc. ACM ☐ ACBM with potential for damage ☐ ACBM with potential for significant damage ☐ Any remaining friable ACBM or friable suspected ACBM	☑ Friable ☐ Non-friable
416-B-002 HA 1		**Asbestos** Comments: 24" DIA. FLUE OFF GENERATOR W/WHT. TSI	" " Qnty: ~15 L/Ft.	☐ Damaged/significantly damaged TSI ACM ☐ Damaged friable surfacing ACM ☐ Significantly damaged friable surfacing ACM ☐ Damaged/significantly damaged friable misc. ACM ☐ ACBM with potential for damage ☐ ACBM with potential for significant damage ☐ Any remaining friable ACBM or friable suspected ACBM	☑ Friable ☐ Non-friable
416-B-003 HA 2		**Asbestos** Comments: GRAY/BLACK SEALANT OFF 12" DIA LINE	" " ~24 L/Ft.	☐ Damaged/significantly damaged TSI ACM ☐ Damaged friable surfacing ACM ☐ Significantly damaged friable surfacing ACM ☐ Damaged/significantly damaged friable misc. ACM	☐ Friable ☑ Non-friable

IW 1/26/05 DK

Collected by: M. DeBois Date 1-24-05 Collector's Signature: Mike D. DeBois Date 1-24-05

Relinquished by: Mike D. DeBois Date/Time 1-24-05 Received by: FEDEX Date/Time

Relinquished by: FEDEX Date/Time Received by: Jennie Bowden Date/Time 1/25/05 0905

Method of Shipment: FEDEX *Sample Condition on Receipt:* ☑ Acceptable ☐ Other Rachel Myers 01/26/05 1305

Authorized by: Date/Time Signature (MUST accompany request!) Mike D. DeBois

Ship to:

Seattle Regional Lab: 4636 E. Marginal Way South, Suite 215, Seattle, WA 98134, Ph: (206) 763-7364, Fax: (206) 763-4189

Atlanta Regional Lab: 3380 Chastain Meadows Parkway, Suite 300, Kennesaw, GA 30144, Ph: (770) 499-7500, Fax: (770) 423-4990

02-82-00AT1

Clayton GROUP SERVICES

REQUEST FOR LABORATORY ANALYTICAL SERVICES

page 2

37815

IMPORTANT:

Date results required: ASAP
Rush charges authorized? No
Phone results? No
Fax results? Yes

Special instructions and/or specific regulatory requirements:

1. Analysis: ✓ PLM __ Semi-Quant TEM
2. Analyze By: ✓ Grouping Until Positive __ All
3. If results <1%, ✓ perform point count
4. Requested Analysis: ✓ Layered __ Composite
5. Turnaround: __ 2-Hour __ 24-Hour ✓ 3-5 Days

Report results to: **Project Manager**
Clayton Group Services
165 S. Union Blvd, Ste 310
Lakewood, CO 80228

Telephone No. **303.988.2585**
Fax No. **303.988.2583**

Client Project No. 90.04152.00

Sample No.	Date Sampled	Sample Description	Location	Category	Photo Ref.
416-B-004 HA3	24 JAN 05	**Asbestos** Comments: WHITE PAINTED CMU BLOCK	EXTERIOR OF BLDG. 416 RADIATOR LOCATION Qnty: < 1,000 ft	☐ Damaged/significantly damaged TSI ACM ☑ Damaged friable surfacing ACM ☐ Significantly damaged friable surfacing ACM ☐ Damaged/significantly damaged friable misc. ACM ☐ ACBM with potential for damage ☐ ACBM with potential for significant damage ☐ Any remaining friable ACBM or friable suspected ACBM	☐ Friable ☐ Non-friable
416-B-005 HA4	↓	**Asbestos** Comments: MORTAR AROUND PIPE PENETRATION THRU WALL	" " Qnty: < 1 LIN. FT.	☐ Damaged/significantly damaged TSI ACM ☐ Damaged friable surfacing ACM ☐ Significantly damaged friable surfacing ACM ☐ Damaged/significantly damaged friable misc. ACM ☐ ACBM with potential for damage ☐ ACBM with potential for significant damage ☐ Any remaining friable ACBM or friable suspected ACBM	☐ Friable ☑ Non-friable
416-B-006 HA5	↓	**Asbestos** Comments: GRAY SEALANT AROUND WALL LOUVERS	" " 22 LIN FT.	☐ Damaged/significantly damaged TSI ACM ☐ Damaged friable surfacing ACM ☐ Significantly damaged friable surfacing ACM ☐ Damaged/significantly damaged friable misc. ACM	☐ Friable ☑ Non-friable

Collected by: [signature] Date 1-24-05 Collector's Signature: [signature] Date 1-24-05
Relinquished by: [signature] Date/Time 1-24-05 Received by: FEDEX Date/Time
Relinquished by: FEDEX Date/Time Received by: [signature] Date/Time 1/25/05 0800

Method of Shipment: FEDEX *Sample Condition on Receipt:* ☑ Acceptable ☐ Other Rachel Melgoza 01/26/05 1305

Authorized by: Date/Time Signature (MUST accompany request!)

Ship to:

Seattle Regional Lab: 4636 E. Marginal Way South
Suite 215
Seattle, WA 98134
Ph: (206) 763-7364
~~Fax: (206) 763-4189~~

Atlanta Regional Lab: 3380 Chastain Meadows Parkway
Suite 300
Kennesaw, GA 30144
Ph: (770) 499-7500
Fax: (770) 423-4990

02-82-00AT1

9-Reg plm

Clayton GROUP SERVICES

REQUEST FOR LABORATORY ANALYTICAL SERVICES

37815

IMPORTANT:

Date results required: ASAP
Rush charges authorized? No
Phone results? No
Fax results? Yes

Special instructions and/or specific regulatory requirements:

1. Analysis: ✓ PLM __ Semi-Ouant TEM
2. Analyze By: ✓ Grouping Until Positive __ All
3. If results <1%, ✓ perform point count
4. Requested Analysis: ✓ Layered __ Composite
5. Turnaround: __ 2-Hour __ 24-Hour ✓ 3-5 Days

Report results to: **Project Manager**
Clayton Group Services
165 S. Union Blvd, Ste 310
Lakewood, CO 80228

Telephone No. **303.988.2585**
Fax No. **303.988.2583**

Client Project No. 90-04152.00

Sample No.	Date Sampled	Sample Description	Location	Category	Photo Ref.
417-B-007 HA 1	24JAN05	**Asbestos** Comments: BLACK BATT INSULATION (ROCKWOOL)	BLDG. 417 INSULATION ON UNDERSIDE CEILING TSI Qnty: >5,000 ft	☐ Damaged/significantly damaged TSI ACM ☐ Damaged friable surfacing ACM ☐ Significantly damaged friable surfacing ACM ☐ Damaged/significantly damaged friable misc. ACM ☐ ACBM with potential for damage ☐ ACBM with potential for significant damage ☐ Any remaining friable ACBM or friable suspected ACBM	☑ Friable ☐ Non-friable
417-B-008 HA 2	"	**Asbestos** Comments: WHT. PAINTED OVER CMU BLOCK	BLDG. 417 CHEMICAL STORAGE LOCKERS Qnty: 400 ft	☐ Damaged/significantly damaged TSI ACM ☐ Damaged friable surfacing ACM ☐ Significantly damaged friable surfacing ACM ☐ Damaged/significantly damaged friable misc. ACM ☐ ACBM with potential for damage ☐ ACBM with potential for significant damage ☐ Any remaining friable ACBM or friable suspected ACBM	☐ Friable ☑ Non-friable
417-B-009 HA 3	"	**Asbestos** Comments: BLACK COVE BASE W/ ALMOND MASTIC	" " 50 LF.	☐ Damaged/significantly damaged TSI ACM ☐ Damaged friable surfacing ACM ☐ Significantly damaged friable surfacing ACM ☐ Damaged/significantly damaged friable misc. ACM	☐ Friable ☑ Non-friable

Collected by: M. DuBois Date 1-24-05 Collector's Signature: [signature] Date 1-24-05
Relinquished by: [signature] Date/Time 1-24-05 Received by: FEDEX Date/Time
Relinquished by: FEDEX Date/Time Received by: [signature] Date/Time 1/25/05 0715

Method of Shipment: FEDEX *Sample Condition on Receipt:* ☑ Acceptable ☐ Other Rachel Mc... 01/26/05 0305

Authorized by: Date/Time Signature (MUST accompany request!) [signature]

Ship to:

Seattle Regional Lab: 4636 E. Marginal Way South
Suite 215
Seattle, WA 98134
Ph: (206) 763-7364
Fax: (206) 763-4189

Atlanta Regional Lab: 3380 Chastain Meadows Parkway
Suite 300
Kennesaw, GA 30144
Ph: (770) 499-7500
Fax: (770) 423-4990

TAB 7

Facility Maintenance Plan

165 South Union Boulevard
Suite 310
Lakewood, CO 80228
303.988.2585
Fax 303.988.2583

Clayton GROUP SERVICES

28 March 2005

Mr. Chad Callan, CHMM
Base Toxics Program Manager
460th Civil Engineering Squadron / CEV
660 South Aspen Street, Stop 86
Buckley Air Force Base, Colorado 80011-9551

Clayton Project No. 90-04152.00

Subject: **Facility Maintenance Plan – NONE REQUIRED**
Building 417
Buckley Air Force Base, Colorado 80011

Dear Mr. Callan:

The following report has been complied from bulk sampling and subsequent analysis of suspect asbestos containing building materials (ACBM) which were identified through visual inspections performed at Building 417 (hereafter, known as the "facility") located on Buckley Air Force Base (AFB), Colorado. Mr. Mike Dubois, a state-licensed asbestos building inspector with Clayton Group Services, Inc. (Clayton) performed the assessment of suspect building materials on 24 January 2005.

The facility identified as Bldg 417 was built in 1992. The 460th CES/CEV provided Clayton with access to and escorts in the facility while performing bulk sampling of suspect ACBM.

All accessible areas within the facility were inspected for suspect ACBM to include thermal systems insulation, surfacing materials, and miscellaneous materials (e.g., floor coverings, mastics and gaskets). When materials suspected of containing asbestos were located, representative samples were collected from each homogeneous material and forwarded for analysis.

Clayton collected a total of three (3) bulk samples of suspect ACBM from numerous homogeneous areas located within the facility. A tabular listing of materials sampled may be referenced in Atch 1; specific locations from where these samples were collected may be referenced in Atch 2.

None of the materials sampled during the course of this assessment showed any detectable quantities of asbestos under laboratory analysis.

Since no ACBM within Bldg. 417 has been identified by a state-licensed inspector following the inspection protocol outlined in Colorado Regulation 8B, a maintenance plan is not currently required. **However, if hidden suspect building materials are encountered during routine operations, renovations, demolition or other activities which do not appear to be like materials previously sampled during the assessment of the facility, sampling and analysis of these materials by a state-certified inspector for the presence of asbestos should be done prior to disturbing the suspected materials.** Examples of these isolated locations include, but are not limited to wall cavities, pipe chases and under existing flooring (i.e.: sheet flooring products, carpet, sub-flooring). A list of suspect materials that may contain asbestos is provided in Atch 3.

Additional information concerning the discovery and management of ACBM within facilities may be referenced in the Buckley AFB Asbestos Operating Plan, dated 1 Sep 04.

This report submitted by: #202

For Mike Dubois
CO Asbestos Building Inspector #805

This report reviewed by:

T. Mark Suggs, REM, OHST
Program Manager

28 March 2005

3 Atchs:

1. Summary of Asbestos Sample Results
2. Sampling Locations Diagram
3. Sample List of Suspect Asbestos-Containing Materials

ATTACHMENTS

Attachment 1

SUMMARY OF ASBESTOS SAMPLE RESULTS

Regulated Building Materials Management System

Summary of Asbestos Sample Analysis Results

Sample Number	Layer	Material Type	Sample Description	Layer Description	Area	Room	Asbestos Containg Material and Content	Condition	AF Priority	Comments
417-B007-012405		TSI	black insulation	Gray and yellow fibrous material	Storage	NA	%	Friable	0	
							%			
							%			
417-B008-012405		Surface Material	white paint & skim coat	Off-white paint on tan and gray gritty material	Storage	NA	%	Non-Friable	0	
							%			
							%			
417-B009-012405	1	Misc.	black covebase & almond mastic	Black vinyl	Storage	NA	%	Non-Friable	0	
							%			
							%			
	2	Misc.	black covebase & almond mastic	Yellow soft mastic	Storage	NA	%	Non-Friable	0	
							%			
							%			

FOOTNOTE: If applicable, the percent asbestos identified in this printout reports the three major asbestos types identified in the sample.

NOTES:
- The limit of detection by PLM is 0.25%.
- 0% with identified asbestos type indicates "trace" quantities with no point count data available; material should be treated as ACM.

02 82 00AT1

Attachment 2

SAMPLING LOCATIONS DIAGRAM

CAD Drawings

The CAD drawings for this building were inadvertently deleted. The drawings will be re-accomplished and provided during Clayton Project No. 90-04152.01.

Attachment 3

SAMPLE LIST OF SUSPECT ASBESTOS-CONTAINING MATERIALS

SAMPLE LIST OF SUSPECT ASBESTOS-CONTAINING MATERIALS

- Acoustical Plaster
- Adhesives
- Asphalt Floor Tile
- Base Flashing
- Blown-in Insulation
- Boiler Insulation
- Breaching Insulation
- Caulking/Putties
- Ceiling Tiles and Lay-in Panels
- Cement Pipes
- Cement Siding
- Cement Wallboard
- Chalkboards
- Construction Mastics (floor tile, carpet, ceiling tile, etc.)
- Cooling Towers
- Decorative Plaster
- Ductwork Flexible Fabric Connections
- Electrical Cloth
- Electrical Panel Partitions
- Electrical Wiring Insulation
- Elevator Brake Shoes
- Elevator Equipment Panels
- Fire Blankets
- Fire Curtains
- Fire Doors
- Fireproofing Materials
- Flooring Backing
- Heating and Electrical Ducts
- High Temperature Gaskets
- HVAC Duct Insulation
- Joint Compounds
- Laboratory Hoods/Table Tops
- Magnesite (Cementous type) Flooring
- Packing Materials (for wall/ floor penetrations)
- Pipe Insulation (corrugated air-cell, block, etc.)
- Roofing Felt
- Roofing Shingles
- Spackling Compounds
- Spray-Applied Insulation
- Taping Compounds (thermal)
- Textured Paints/Coatings
- Thermal Paper Products
- Vinyl Floor Tile
- Vinyl Sheet Flooring
- Vinyl Wall Coverings
- Wallboard

Note: This list does not include every product that may contain asbestos; nor is it a specific list of materials. It is intended as a general guide, primarily for training, to show which types of materials that may contain asbestos.

165 South Union Boulevard
Suite 310
Lakewood, CO 80228
303.988.2585
Fax 303.988.2583

8 February 2006

Mr. Chad Callan, CHMM
Toxics Program Manager
460th CES/CEV
660 South Aspen Street, Stop 86
Buckley Air Force Base, Colorado 80011-9551

Clayton Project No. 90-04152.01

Subject: **Visual Survey for Asbestos-Containing Building Materials:**
Building 423, BE Storage CV Facility
Buckley Air Force Base, Colorado

Dear Mr. Callan:

Mr. T. Mark Suggs, a state-certified asbestos building inspector with Clayton Group Services, Inc. (Clayton) performed a survey for suspect asbestos-containing building materials (ACBM) in Bldg 423 (hereafter, known as the "facility"), Buckley Air Force Base (AFB), Colorado on 18 July 2005. The purpose of this survey was to identify building materials, which may contain asbestos, then collect and analyze samples as necessary to determine asbestos content. Subsequent to the collection and analysis of samples, a maintenance plan specific to this facility would be developed as necessary.

The facility identified as Bldg 423, a BE Storage CV facility, was built circa 1998. 2SWS escorts provided Clayton with access to the facility while performing the visual inspection.

All readily accessible areas within the facility were visually surveyed for suspect ACBM to include thermal systems insulation, surfacing materials, and miscellaneous materials (e.g., floor coverings, mastics and gaskets). As a result of this survey, no suspect ACBM was observed. Clayton did not sample suspect ACBM where the integrity of the material would be compromised if sampled (e.g., fire doors). Additionally, Clayton did not look for suspect materials in hidden spaces (e.g., behind walls, above solid ceilings, inside boilers, or inside other mechanical equipment) that would require destructive methods to access for inspection and sampling.

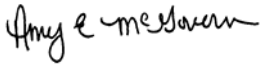
If hidden suspect building materials are encountered during routine operations, renovations, demolition or other activities which do not appear to be like materials previously sampled during the assessment of the facility, sampling and analysis of these materials by a state-certified inspector for the presence of asbestos should be

done prior to disturbing the suspected materials. For such occurrences, a list of suspect materials that may contain asbestos is provided in the attachment.

Additional information concerning the discovery and management of ACBM within facilities may be referenced in the Buckley AFB Asbestos Operating Plan.

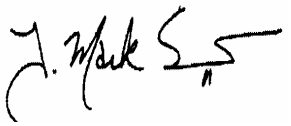
Thank you for the opportunity to serve you. If you have any questions regarding the content of this report, please contact either of the undersigned.

Sincerely,



Amy McGovern
Project Manager
CO Asbestos Building Inspector #12534

Reviewed by:



T. Mark Suggs, OHST, REM
Program Manager
Co Asbestos Building Inspector #9966

AEM/aem

Atch: Sample List of Suspect Asbestos-Containing Materials

Attachment

SAMPLE LIST OF SUSPECT ASBESTOS-CONTAINING MATERIALS

SAMPLE LIST OF SUSPECT ASBESTOS-CONTAINING MATERIALS

- Acoustical Plaster
- Adhesives
- Asphalt Floor Tile
- Base Flashing
- Blown-in Insulation
- Boiler Insulation
- Breaching Insulation
- Caulking/Putties
- Ceiling Tiles and Lay-in Panels
- Cement Pipes
- Cement Siding
- Cement Wallboard
- Chalkboards
- Construction Mastics (floor tile, carpet, ceiling tile, etc.)
- Cooling Towers
- Decorative Plaster
- Ductwork Flexible Fabric Connections
- Electrical Cloth
- Electrical Panel Partitions
- Electrical Wiring Insulation
- Elevator Brake Shoes
- Elevator Equipment Panels
- Fire Blankets
- Fire Curtains
- Fire Doors
- Fireproofing Materials
- Flooring Backing
- Heating and Electrical Ducts
- High Temperature Gaskets
- HVAC Duct Insulation
- Joint Compounds
- Laboratory Hoods/Table Tops
- Magnesite (Cementous type) Flooring
- Packing Materials (for wall/ floor penetrations)
- Pipe Insulation (corrugated air-cell, block, etc.)
- Roofing Felt
- Roofing Shingles
- Spackling Compounds
- Spray-Applied Insulation
- Taping Compounds (thermal)
- Textured Paints/Coatings
- Thermal Paper Products
- Vinyl Floor Tile
- Vinyl Sheet Flooring
- Vinyl Wall Coverings
- Wallboard

Note: This list does not include every product that may contain asbestos; nor is it a specific list of materials. It is intended as a general guide, primarily for training, to show which types of materials that may contain asbestos.

LIMITED ASBESTOS INSPECTION FOR RENOVATION

Buckley Space Force Base
Building 423
484 Beaver Creek St,
Aurora, CO, 80011

Prepared for:

US Army Corps of Engineers
Attn: Brian Kramer
19070 E Sunlight Way T1012 MS53,
Buckley SFB, CO, 80011-9574

Prepared by:
Foothills Environmental,
A Division of SET Environmental, Inc.
11099 West 8th Avenue
Denver, CO 80215

May 30th, 2025
Project No. AS25050/2505-1289

ACRONYMS

ACM	Asbestos Containing Material
ACBM	Asbestos Containing Building Material
AIHA	American Industrial Hygiene Association
CDPHE	Colorado Department of Public Health and Environment
CFC	Chlorofluorocarbons
CFL	Compact Fluorescent Lamp
EPA	United States Environmental Protection Agency
HID	High Intensity Discharge
OSHA	Occupational Safety and Health Administration
NVLP	National Voluntary Laboratory Accreditation Program
PACM	Presumed Asbestos Containing Material
PCB	Polychlorinated Biphenyls
PLM	Polarized Light Microscopy
RACM	Regulated Asbestos Containing Material
SVF	Sheet Vinyl Flooring
TEM	Transmission Electron Microscopy
TSI	Thermal System Insulation
UHW	Universal Hazardous Waste

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1.0 EXECUTIVE SUMMARY

At the request of US Army Corps of Engineers, Foothills Environmental (FE), a Division of SET Environmental, Inc., conducted a limited asbestos inspection at Buckley Space Force Base on 484 Beaver Creek St. in Aurora, Colorado prior to a planned renovation to the building 423 office and bathroom area inside the building. This inspection included asbestos sampling for building materials that may be disturbed as part of the planned renovation project as described by US Army Corps of Engineers personnel during a site visit. Harrison Massengale, EPA accredited and CDPHE certified asbestos inspector, conducted the inspection.

Random bulk samples were collected of suspect asbestos containing building materials that may be impacted by the renovation of the subject site. This asbestos inspection was conducted in general accordance with the guidelines published as the Environmental Protection Agency's Final Rule: Title II of the Toxic Substances Control Act (TSCA), 15 USC, Sections 2641 through 2654 or in compliance with 40 CFR, Part 763 and the Colorado Department of Public Health and Environment (CDPHE) Regulation #8.

A total of seventeen (17) suspect asbestos containing material samples were collected for this investigation.

- No Asbestos-Containing Materials were identified or confirmed in samples collected during this inspection.

1.1 Asbestos Materials Requiring Removal Prior to Renovation or Demolition

Regulated Asbestos-Containing Material (RACM) means (a) friable asbestos-containing material, (b) Category I non-friable ACM that has become friable, (c) Category I non-friable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading or (d) Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations.

Non-RACMs are those non-friable materials not likely to be rendered friable during the normal demolition process, therefore they are less likely to release airborne asbestos. Under normal demolition activities, non-RACMs that are non-friable Category I materials (gaskets, resilient flooring, adhesives, and asphalt roofing) and similar non-friable Category II are allowed by EPA and CDPHE regulations to remain during normal building demolition, and can be disposed of as normal demolition debris, provided these materials remain non-friable during demolition activities and the landfill will accept the waste as solid waste.

The following materials were identified during this investigation:

Table 1 – RACM

ACM Description/Homogeneous Area(s)	Condition	Type / Friable or Non-Friable	Analytical Result	Approx. Quantity	Material Locations
None					

Table 2 – Non-RACM (>1%)

ACM Description/Homogeneous Area(s)	Condition	Type / Friable or Non-Friable	Analytical Result	Approx. Quantity	Material Locations
None					

Table 3 – Trace (<1%) Materials

Material Description/Homogeneous Area(s)	Condition	Type / Friable or Non-Friable	Analytical Result	Approx. Quantity	Material Locations
None					

1.2 Scope of Work

The combined goals of this inspection were to:

1. Identify asbestos-containing materials (ACM) throughout the interior and exterior of the renovation areas and to document the location, condition, friability, and quantity of each identified material.
2. Make appropriate recommendations on how to approach each material identified as an ACM prior to renovation.
3. Compile sample data information, observations obtained from the site visits, conclusions, and recommendations into a report.

1.3 Standard Bulk Sampling and Analytical Procedures

1.3.1 Asbestos

This asbestos inspection was completed in general accordance with the Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollutants (NESHAP) regulation using bulk sampling techniques referenced in OSHA 29 CFR 1910.1001, which in turn, references U.S. EPA Asbestos Hazard Emergency Response Act (AHERA) protocol.

The inspection was completed by separating materials into Homogeneous Areas. A homogeneous area (material) is defined as an area containing a material that appears similar throughout with regard to color, texture, and date of application. Individual systems that were inspected, but not suspected to contain asbestos, are not included in this report. Such systems include concrete, carpet, fiberglass, plastic, and wood products. From the list of suspect homogeneous areas, a physical assessment was performed for each material on the list. A physical assessment includes evaluating the condition, friability, and amount of damage of each material. By definition, "friable" materials are those that can crumble or reduce to powder by hand pressure when dry. Each material on the list was further classified into one of three categories, which have specific sampling requirements for each category.

Surfacing Materials: Refers to spray or troweled applied surfaces such as plaster ceilings and walls, fireproofing, textured paints, textured plasters, and spray-applied acoustical surfaces.

Thermal System Insulation: Refers to insulation used to inhibit heat gain or loss on pipes, boilers, tanks, ducts, and various other building components.

Miscellaneous Materials: Refers to friable and non-friable products and materials that do not fit in any of the above two (2) categories such as resilient floor covering,

baseboards, mastics, adhesives, roofing material, caulking, glazing, and siding. This category also contains wallboard, joint compound, and ceiling tiles.

The condition of suspect materials was evaluated as "good", "damaged", or "significantly damaged" using the following parameters:

Good - material with no visible damage or deterioration or showing only very limited damage or deterioration.

Damaged - material which has deteriorated or sustained physical injury such that the internal structure (cohesion) of the material is inadequate or, if applicable, which has delaminated such that the bond to the substrate (adhesion) is inadequate or which for any other reason lacks fiber cohesion or adhesion qualities. Damaged materials are those that have <10% scattered or <25% localized damage.

Significantly Damaged - material which has extensive and severe damage. Significantly damaged materials are those that have >10% scattered or > 25% localized damage.

Each suspect material was also classified as friable (F), Category I non-friable (Cat. I), or Category II non-friable (Cat. II), according to the U.S. EPA National Emissions Standard for Hazardous Air Pollutants (NESHAP) definitions.

The sampled materials were wetted with an amended water solution to minimize the release of airborne fibers during sample collection. A sample collection hand tool, cleaned after the collection of each sample, was used to remove a small sample of suspect material. Each suspect material was placed into a small plastic bag, labeled, and sealed. Upon completion of sampling activities, samples were placed into a sealed container along with a chain of custody forms and delivered for analysis to Reservoirs Environmental, Inc. in Arvada, Colorado. Reservoirs Environmental, Inc. is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) for conducting bulk and air sample analyses for asbestos.

As specified in 40 CFR Part 763, Subpart F, Appendix A, each sample was analyzed using Polarized Light Microscopy (PLM) in accordance with U.S. EPA Method 600/R-93/116, June 1993. Some samples will contain numerous "layers". The laboratory will classify and report each layer found with a corresponding asbestos content. In some instances, bulk samples of similar materials (HAs) are reported as having a different number of layers. Percent asbestos for separate layers and total for the sample are delineated in the laboratory report. Unused portions of samples are archived for six months unless the client requests special handling.

The Environmental Protection Agency (EPA) defines ACM as a material containing greater than 1.0 percent (%) asbestos. Both friable and non-friable materials were sampled. A friable material is a material that when dry may be crumbled, pulverized, or reduced to powder by hand pressure. Because friable materials are more easily damaged and more likely to release fibers into the air, they are of greater concern than non-friable ACM.

Materials containing 1% or less asbestos are considered Trace by EPA. The Occupational Safety and Health Administration (OSHA) Construction Asbestos Standard 29 CFR 1926.1101 contains work practice and engineering control requirements and prohibitions that must be observed regardless of the percentage of

asbestos in installed construction materials. Even though these materials are not regulated under the NESHAP for demolition, consideration must be given for worker exposure during any activities that may disturb them.

1.4 Building Description

Building 423 is located on the west side of the restricted area at Buckley Space Fore Base. The scope of this project was limited to the office and bathroom area inside of building 423. The office and bathroom area inside of building 423 is constructed of drywall walls on either wood or metal framing with floor tiles in the bathroom, carpet squares over the floor tile in the office spaces, and ceiling tiles in the office spaces with a drywall ceiling in the bathroom.

1.5 Statement of Inaccessibility

Accessible areas of the structure were inspected for ACM and LBP within the described scope of work. Underground conduit, utility chases, electrical panels, instruments, or other appurtenances were not inspected. Attempts were made to identify and access suspect materials; however, the potential for additional unidentified materials may exist within inaccessible areas, such as machinery, in equipment, ceiling and wall plenums, underground, etc. Any suspect materials located in these areas should be assumed asbestos-containing until sample collection can be performed and subsequent analyses prove otherwise.

The conclusions of the report are professional opinions based solely upon site observations and interpretations of analyses as described in our report. The opinions presented herein apply to site conditions at the time of our investigation, and the interpretation of current regulations pertaining to regulated materials. Therefore, our opinions and recommendations may not apply to future conditions that may exist at the building, which we have not had the opportunity to evaluate. The regulations should always be verified prior to any work involving regulated materials.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in this area at the time this report was prepared. No other conditions, expressed or implied, should be assumed.

2.0 ASBESTOS-CONTAINING MATERIAL (ACM) LOCATION SUMMARY

The following sections summarize the survey findings and analytical results for suspect ACM sampled at the subject site. The ACM summary tables shown have been prepared for each general sample location: floors, walls, and ceilings. These tables are organized to show each material analyzed, its asbestos content, and sample location. Representative samples of suspect materials were sent to an accredited laboratory for analysis.

2.1 Bulk Sample Inspection Summary

The following suspect materials were identified and sampled during this inspection. Each material is listed by material type (surfacing, TSI, or miscellaneous) and description following:

2.1.1 Suspect Surfacing Materials

- TEX1 – Orange peel texture

2.1.2 Suspect Thermal System Insulation Materials

- None

2.1.3 Suspect Miscellaneous Materials

- FTM1 – Floor tiles and mastic (tan)
- CBM1 – Light brown cove base with tan mastic
- CBM2 – Grey cove base with tan mastic
- DWJ1 – Drywall and joint compound
- CT1 – Lay in place ceiling tiles
- CSM1 – Carpet squares with black mastic

3.0 ASBESTOS SAMPLE RESULTS TABLE

The following tables summarize asbestos sample results collected for this project. A copy of analytical results is attached in Appendix B to this report for your reference. Sample locations are described in Figure 1 attached in Appendix A.

The following table summarizes the results of the samples collected**:**

Data #	Sample Number	Material Description	Sample Location	Condition/ Friability	ACM Category	Approx. Quantity	Analytical Result
1	TEX1-1	Orange peel texture	Behind door in bathroom on west wall	G/NF	Non-ACM	1,000 SF	ND
2	TEX1-2		Behind door in middle office on west wall				ND
3	TEX1-3		Middle of north wall outside of area				ND
4	TEX1-4		East side of north wall outside of area				ND
5	TEX1-5		Southeast corner on outside of area				ND
6	FTM1-1	Floor tile and mastic (tan)	South side of bathroom sink	G/NF	Non-ACM	77 SF	ND*
7	FTM1-2		Northwest corner of bathroom				ND*
8	CBM1-1	Light brown cove base with tan mastic	Left side of door outside of middle office	G/NF	Non-ACM	95 SF	ND*
9	CBM1-2		Middle of east wall in middle office				ND*
10	CBM2-1	Grey cove base with tan mastic	East side of door inside of bathroom	G/NF	Non-ACM	37 SF	ND*
11	CBM2-2		Middle of west wall inside of bathroom				ND*
12	DWJ1-1	Drywall and joint compound	Northwest corner of bathroom	G/NF	Non-ACM	1,000 SF	ND*
13	DWJ1-2		Middle of north wall in middle office above ceiling tiles				ND*
14	CT1-1	Lay in place ceiling tiles	Above doorway to middle office	G/F	Non-ACM	260 SF	ND
15	CT1-2		Southwest corner on ceiling in middle office				ND
16	CSM1-1	Carpet squares with black mastic	Outside of middle office's door	G/NF	Non-ACM	260 SF	ND
17	CSM1-2		Middle of door in middle office				ND

SF=square feet
LF=linear feet

F= friable
NF=non-friable

G=good
D=damaged
SD=significantly damaged

ND=none detected
*= multiple layers
BOLD = ACM

4.0 CONCLUSIONS and RECOMMENDED ACTIONS

4.1 Asbestos

Asbestos-Containing Materials – General

Removal, in accordance with the EPA NESHAP, is required of materials with an asbestos content greater than one percent (1%) that are friable or will be made friable during renovation or demolition activities. Friable means that the material, when dry may be crumbled, pulverized, or reduced to powder by hand pressure.

The Occupational Safety and Health Administration (OSHA) Construction Asbestos Standard 29 CFR 1926.1101 contains work practice and engineering control requirements and prohibitions that must be observed regardless of the percentage of asbestos in the installed construction materials. The employer still must follow the requirements in paragraphs (g)(1) [except (g)(1)(i)], (g)(2) and (g)(3) that describe engineering and work practice controls operation as well as prohibitions that must be observed regardless of the percentage of asbestos in construction materials. The standard also has exposure-based requirements consisting of a 0.1 fiber/ cc 8-hour Time Weighted Average (TWA) Personal Exposure Limit (PEL) and a 1 fiber/ cc 30-minute excursion limit.

The National Emission Standard for Hazardous Air Pollutants (NESHAP) regulations set forth by the U.S. Environmental Protection Agency control asbestos emissions from renovation and demolition activities.

The following sections describe materials that were identified during this inspection and recommended actions prior to renovation or demolition.

4.1.1 Friable ACM

Friable ACM must be removed prior to demolition.

The following materials were identified as friable ACM during the investigation:

- No materials were identified as friable ACM during this inspection.

4.1.2 Non-friable ACM

The following materials were identified as non-friable ACM during the inspection:

- No materials were identified as non-friable ACM during this inspection.

4.1.3 Materials Containing 1% or Less Asbestos (Trace)

The following materials were identified as trace during this inspection:

- No materials were identified as trace asbestos during this inspection.

4.1.4 RACM vs NON-RACM

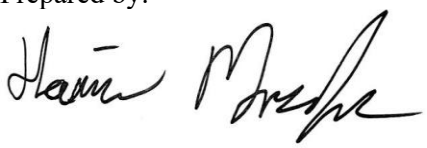
ACM identified that are nonfriable usually remain nonfriable in their current condition; however, they may become friable during renovation or demolition activities. These materials must be removed prior to activities that will render them friable including (drilling, sanding, grinding, or cutting). Removal is recommended before demolition unless minimal or no breakage is reasonably achievable.

Removal of nonfriable ACM must be performed by trained personnel according to procedures outlined in current regulations. Removal activities must be completed in compliance with the OSHA Asbestos in Construction standard 29 CFR 1926.1101 as a Class II work operation, which includes engineering controls and monitoring. Some landfills allow the materials to be disposed of with construction debris; however, the waste hauler and landfill must be notified that they are receiving a Category II nonfriable asbestos material. If the material is removed as an asbestos removal project, it should be disposed of as nonfriable asbestos waste.

5.0 LIMITATIONS

This report describes the locations and conditions of suspect materials identified in the facilities during the inspections. FE represents that our services are performed within the limits prescribed by applicable regulations and in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is made to the client, expressed or implied, and no warranty or guarantee is included or intended.

Prepared by:



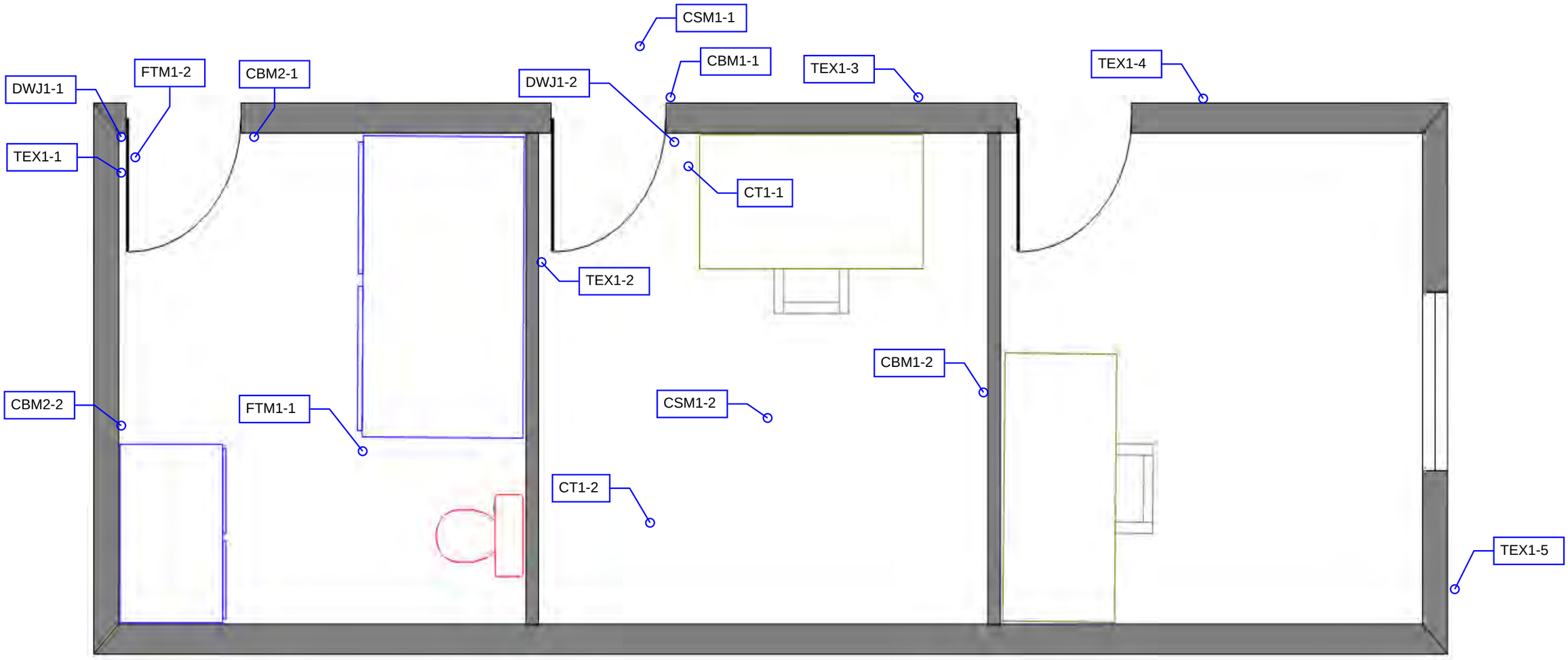
Harrison Massengale
Industrial Hygienist
CDPHE Asbestos Building Inspector Cert# 29590

Reviewed by:

Andre Gonzalez, CIH
General Manager

Appendix A

Asbestos Sample Locations Drawings



Non-Detect Sample
Sample Containing Trace Asbestos
Sample Containing Asbestos

Building 423 Buckley Space Force Base 484 Beaver Creek St, Aurora, CO, 80011	FE Project #AS25050	Date: 05/29/2025	Figure 1 Sample Locations Drawing
	Approved by: AG	Drawn by: HM	

Foothills Environmental
A Division of SET Environmental, Inc

Foothills Environmental, a Division of SET Environmental, Inc
11099 W 8th Avenue
Lakewood, CO, 80215

Appendix B

Asbestos Laboratory Results

eurofins | Built Environment Testing Reservoirs

May 30, 2025

Subcontractor Number:
Laboratory Report: **RES 661606-1**
Project #/P.O. #: **PO000090611**
Project Description: **Buckley Building 423**

Harrison Massengale
Foothills Environmental, Inc.
11099 W. 8th Avenue
Lakewood CO 80215

Dear Harrison,

Eurofins Reservoirs is an analytical laboratory accredited for the analysis of Industrial Hygiene and Environmental matrices by the National Voluntary Laboratory Accreditation Program (NVLAP), Lab Code 101896-0 for Transmission Electron Microscopy (TEM) and Polarized Light Microscopy (PLM) analysis and the American Industrial Hygiene Association (AIHA LAP, LLC), Lab ID 101533 for Phase Contrast Microscopy (PCM) analysis. This laboratory is currently proficient in both Proficiency Testing and PAT programs respectively.

Eurofins Reservoirs has analyzed the following samples for asbestos content as per your request. The analysis has been completed in general accordance with the appropriate methodology as stated in the attached analysis table. The results have been submitted to your office.

RES 661606-1 is the job number assigned to this study. This report is considered highly confidential and the sole property of the customer. Eurofins Reservoirs will not discuss any part of this study with personnel other than those of the client. The results described in this report only apply to the samples analyzed, as received and with the information provided by the customer. This report must not be used to claim endorsement of products or analytical results by NVLAP or any agency of the U.S. Government. This report shall not be reproduced except in full, without written approval from Eurofins Reservoirs. Samples will be disposed of after sixty days unless longer storage is requested. If you have any questions about this report, please feel free to call 303-964-1986.

Sincerely,

Jeanne Spencer
by Christina Tiggemann

Jeanne Spencer
President

DATA QA
05/30/2025

EUROFINS RESERVOIRS ENVIRONMENTAL, INC

NVLAP Lab Code 101896-0
AIHA LAP, LLC. LAB ID 101533

TABLE: I ANALYSIS: PLM BULK ANALYSIS, PERCENTAGE COMPOSITION BY VOLUME

RES Job Number: **RES 661606-1**
Client: **Foothills Environmental, Inc.**
Client Project/P.O.: **PO000090611**
Client Project Description: **Buckley Building 423**
Date Samples Received: **May 29, 2025**
Analysis Type: **EPA 600/R-93/116 - Short Report, Bulk**
Turnaround: **Priority**
Date Samples Analyzed: **May 30, 2025**

NA = Not Analyzed
NR = Not Received
ND = None Detected
TR = Trace; <1 % Visual Estimate
Trem-Act = Tremolite-Actinolite

Laboratory Sample ID / Client Sample Number	LAYER	Physical Description	Sub Part (%)	Asbestos Content: Mineral	Asbestos Content: Visual Estimate (%)	Non-Asbestos Fibrous Components (%)	Non-Fibrous Components (%)
661606 - TEX1-1	A	White texture w/ off-white paint	100		ND	0	100.0
661606 - TEX1-2	A	Tan/gray drywall w/ off-white paint	100		ND	75	25.0
661606 - TEX1-3	A	White texture w/ gray paint	100		ND	0	100.0
661606 - TEX1-4	A	Tan/off-white drywall w/ off-white paint	100		ND	75	25.0
661606 - TEX1-5	A	White texture w/ gray paint	100		ND	0	100.0
661606 - FTM1-1	A	Yellow adhesive	4		ND	0	100.0
	B	Gray floor tile	96		ND	0	100.0
661606 - FTM1-2	A	Yellow adhesive	1		ND	0	100.0
	B	Gray floor tile	99		ND	0	100.0
661606 - CBM1-1	A	Cream adhesive	4		ND	0	100.0
	B	Gray cove base	96		ND	0	100.0
661606 - CBM1-2	A	Cream adhesive	5		ND	0	100.0
	B	Gray cove base	95		ND	0	100.0
661606 - CBM2-1	A	Cream adhesive	6		ND	0	100.0
	B	Gray cove base	94		ND	0	100.0

TEM Analysis recommended for organically bound material (i.e. floor tile) if PLM results are <1%.

EUROFINS RESERVOIRS ENVIRONMENTAL, INC

NVLAP Lab Code 101896-0
AIHA LAP, LLC. LAB ID 101533

TABLE: I ANALYSIS: PLM BULK ANALYSIS, PERCENTAGE COMPOSITION BY VOLUME

RES Job Number: **RES 661606-1**
Client: **Foothills Environmental, Inc.**
Client Project/P.O.: **PO000090611**
Client Project Description: **Buckley Building 423**
Date Samples Received: **May 29, 2025**
Analysis Type: **EPA 600/R-93/116 - Short Report, Bulk**
Turnaround: **Priority**
Date Samples Analyzed: **May 30, 2025**

NA = Not Analyzed
NR = Not Received
ND = None Detected
TR = Trace; <1 % Visual Estimate
Trem-Act = Tremolite-Actinolite

Laboratory Sample ID / Client Sample Number	LAYER	Physical Description	Sub Part (%)	Asbestos Content: Mineral	Asbestos Content: Visual Estimate (%)	Non-Asbestos Fibrous Components (%)	Non-Fibrous Components (%)
661606 - CBM2-2	A	Cream adhesive	5		ND	0	100.0
	B	Gray cove base	95		ND	0	100.0
661606 - DWJ1-1	A	Cream tape	10		ND	95	5.0
	B	Off-white/white joint compound	25		ND	0	100.0
	C	Gray/tan drywall	65		ND	15	85.0
661606 - DWJ1-2	A	Off-white compound w/ colorless fibrous woven material	10		ND	10	90.0
	B	Off-white resinous compound	25		ND	0	100.0
	C	Gray/tan drywall	65		ND	20	80.0
661606 - CT1-1	A	Tan/white ceiling tile	100		ND	80	20.0
661606 - CT1-2	A	Tan/white ceiling tile	100		ND	85	15.0
661606 - CSM1-1	A	Gray carpet w/ clear adhesive	100		ND	50	50.0
661606 - CSM1-2	A	Gray carpet w/ clear adhesive	100		ND	50	50.0

TEM Analysis recommended for organically bound material (i.e. floor tile) if PLM results are <1%.

Christina Tiggemann
Analyst

eurofins | Built Environment Testing Reservoirs

RES Job #: 661606

SUBMITTED BY		INVOICE TO		CONTACT INFORMATION		SERIES
Company:	Foothills Environmental, Inc.	Company:	Foothills Environmental, Inc.	Contact:	Harrison Massengale	-1 PLM Priority
Address:	11099 W. 8th Avenue	Address:	11099 W. 8th Avenue	Phone:	(720) 357-4704	
				Fax:		
	Lakewood, CO 80215		Lakewood, CO 80215	Cell:		
Project Number and/or P.O. #:	PO000090611	Project Zip Code:		Final Data Deliverable Email Address:		
Project Description/Location:	Buckley Building 423			hmassengale@setenv.com (+ 1 ADDNL. CONTACTS)		

ASBESTOS LABORATORY

PLM / PCM / TEM DTL RUSH PRIORITY STANDARD

CHEMISTRY LABORATORY

Dust RUSH PRIORITY STANDARD

Metals RUSH PRIORITY STANDARD *PRIOR NOTICE REQUIRED FOR SAME DAY TAT

Organics* SAME DAY RUSH PRIORITY STANDARD

MICROBIOLOGY LABORATORY

Viable Analysis** PRIORITY STANDARD

Medical Device Analysis RUSH STANDARD **TAT DEPENDENT ON SPEED OF MICROBIAL GROWTH

Mold Analysis RUSH PRIORITY STANDARD

****Turnaround times establish a laboratory priority, subject to laboratory volume and are not guaranteed. Additional fees apply for afterhours, weekends and holidays.****

Special Instructions:

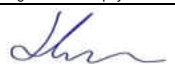
REQUESTED ANALYSIS

VALID MATRIX CODES

Air = A | Bulk = B
Dust = D | Food = F
Paint = P | Soil = S
Surface = SU | Swab = SW
Tape = T | Wipe = W
Drinking Water = DW
Waste Water = WW
ASTM E1792 approved wipe media only

Client Sample ID Number (Sample ID's must be unique)	ASBESTOS: PLM - PLM Short Report (EPA/600/R-93/116)	ASBESTOS: TEM	ASBESTOS: PCM	CHEMISTRY: DUST	CHEMISTRY: METALS	CHEMISTRY: ORGANICS	MICROBIOLOGY: VIABLES	MICROBIOLOGY: MEDICAL	MICROBIOLOGY: MOLD	ICO	Sample Volume (L) / Area	Sample Temperature (°C)	Length(or Aliquots) x Width(or Area/Aliquot)	Matrix Code	# of Containers	Date Collected mm/dd/yy	Time Collected hh:mm	Laboratory Analysis Instructions
1 TEX1-1	X													B				
2 TEX1-2	X													B				
3 TEX1-3	X													B				
4 TEX1-4	X													B				
5 TEX1-5	X													B				
6 FTM1-1	X													B				
7 FTM1-2	X													B				
8 CBM1-1	X													B				
9 CBM1-2	X													B				
10 CBM2-1	X													B				
11 CBM2-2	X													B				
12 DWJ1-1	X													B				
13 DWJ1-2	X													B				

Eurofins Reservoirs Environmental, Inc establishes a unique Lab Sample ID, for each sample, by preceding each unique Client Sample ID with the laboratory RES Job Number.
Eurofins Reservoirs Environmental, Inc will analyze incoming samples based on information received and will not be responsible for errors or omissions in calculations resulting from the inaccuracy of original data. By signing, client/company representative agrees that submission of the following samples for requested analysis as indicated on this Chain of Custody shall consitute an analytical services agreement with payment terms of NET 30 days. Failure to comply with payment terms may result in a 1.5% monthly interest surcharge.

Relinquished By:		Harrison Massengale	Date/Time: 05/29/2025 11:46:00	Sample Condition: Acceptable
Received By:		Anna Shilo	Date/Time: 05/29/2025 11:50:41	Carrier: Hand

eurofins | Built Environment Testing Reservoirs

RES Job #: **661606**

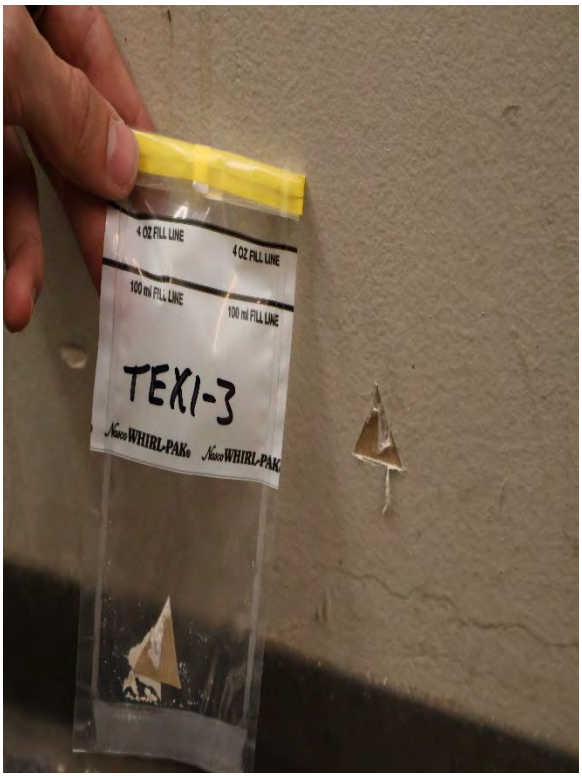
Submitted By: **Foothills Environmental, Inc.**

		REQUESTED ANALYSIS									VALID MATRIX CODES							LAB NOTES
											Air = A			Bulk = B				
											Dust = D			Food = F				
											Paint = P			Soil = S				
											Surface = SU			Swab = SW				
											Tape = T			Wipe = W				
											Drinking Water = DW							
											Waste Water = WW							
											ASTM E1792 approved wipe media only							
		PLM - PLM Short Report (EPA/600/R-93/116)	TEM	PCM	DUST	METALS	ORGANICS	VIABLES	MEDICAL	MOLD	ICO	Sample Volume (L) / Area	Sample Temperature (°C)	Length(or Aliquots) x Width(or Area/Aliquot)	Matrix Code	# of Containers	Date Collected mm/dd/yy	Time Collected hh:mm	Laboratory Analysis Instructions
Client Sample ID Number	(Sample ID's must be unique)	**ASBESTOS**			**CHEMISTRY**			**MICROBIOLOGY**			**ICO**								
14	CT1-1	X													B				
15	CT1-2	X													B				
16	CSM1-1	X													B				
17	CSM1-2	X													B				

Appendix C

Photographs

Sample: TEX1-1
Results: None detected

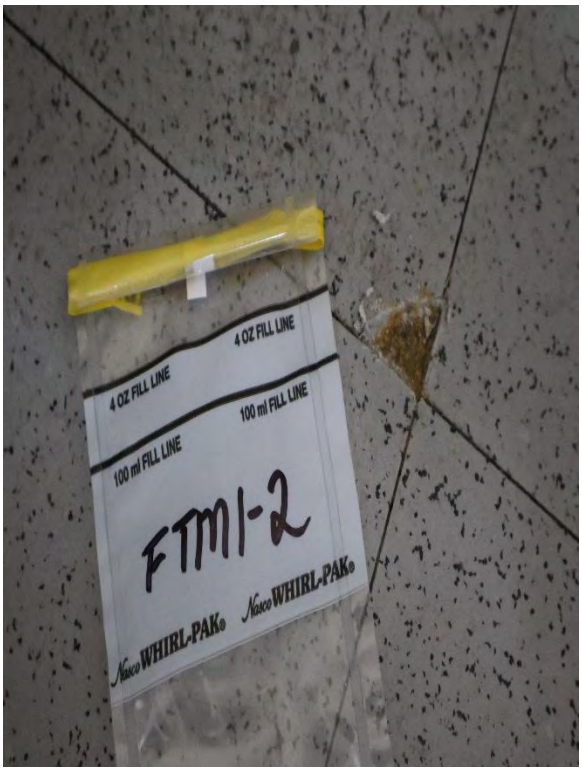


Sample: TEX1-3
Results: None detected

Sample: TEX1-2
Results: None Detected

Sample: TEX1-4
Results: None detected

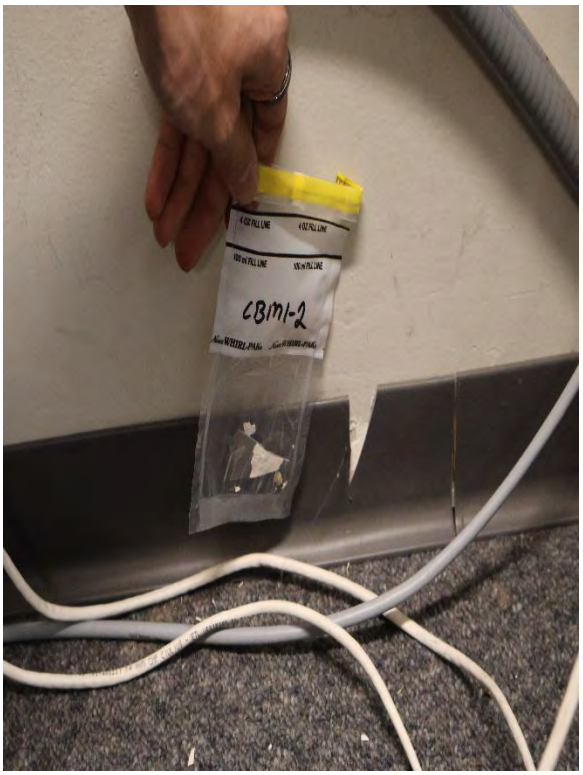
Sample: TEX1-5
Results: None detected



Sample: FTM1-2
Results: None detected

Sample: FTM1-1
Results: None detected

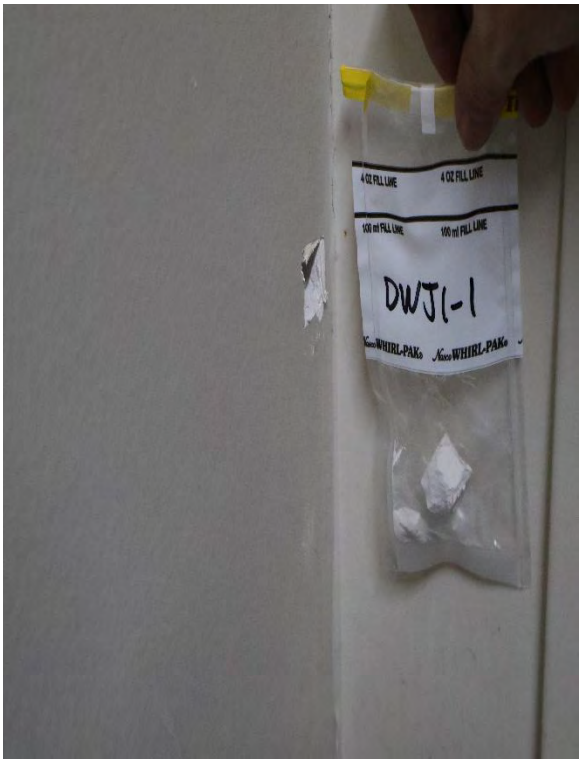
Sample: CBM1-1
Results: None Detected



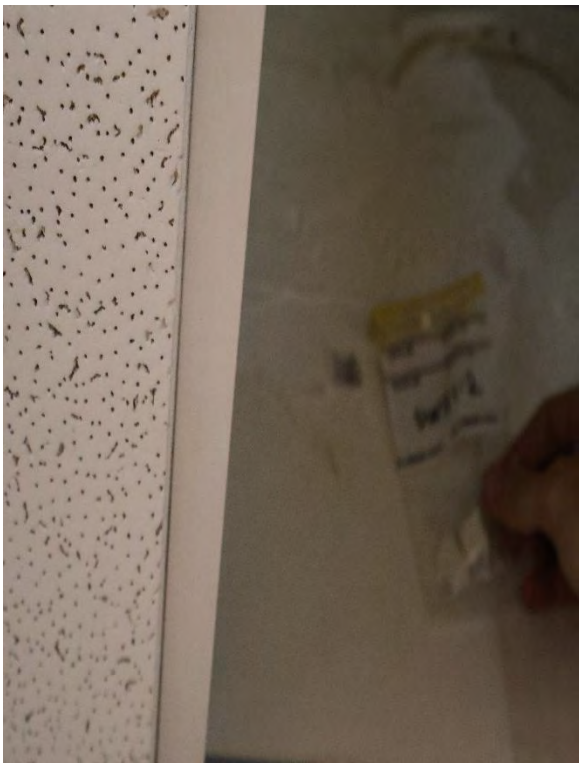
Sample: CBM1-2
Results: None detected

Sample: CBM2-2
Results: None detected

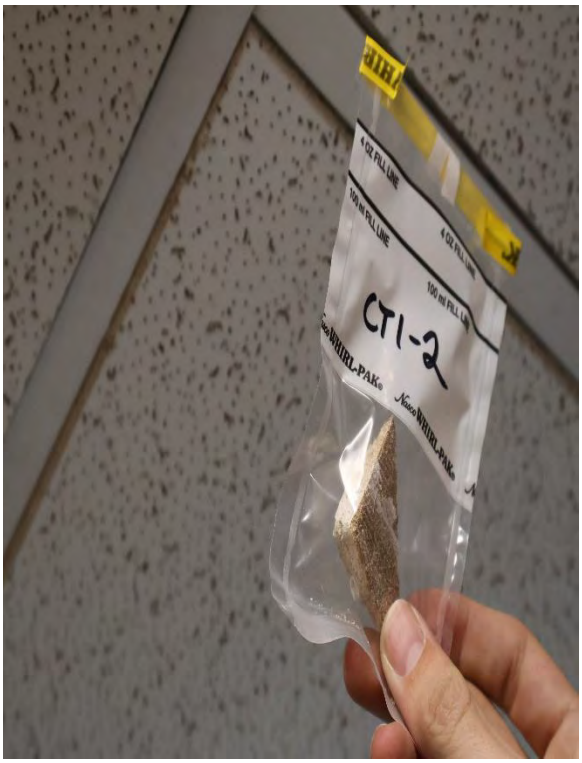
Sample: CBM2-1
Results: None detected



Sample: DWJ1-1
Results: None detected



Sample: DWJ1-2
Results: None detected



Sample: CT1-2
Results: None detected

Sample: CT1-1
Results: None Detected

Sample: CSM1-1
Results: None detected

Sample: CSM1-2
Results: None detected

Appendix D

Certifications

Colorado Department
of Public Health
and Environment

ASBESTOS CERTIFICATION*

This certifies that

Harrison L. Massengale

Certification No.: 29590

has met the requirements of 25-7-507, C.R.S. and Air Quality Control Commission Regulation No. 8, Part B, and is hereby certified by the state of Colorado in the following discipline:

Building Inspector*

Issued: **February 28, 2025**

Expires: **March 22, 2026**

** This certificate is valid only with the possession of a current Division-approved training course certification in the discipline specified above.*

Authorized Division Representative

SEAL

M.E. TRAINING
3900 S. Federal Blvd.
Englewood, CO 80110

(720) 441-5049
info@metraining247.com
www.metraining247.com

Certificate of Completion

Harrison L. Massengale

has successfully completed 4 hours of annual refresher training required under section 206 of the Toxic Substance Control Act (TSCA), Title II.

"BUILDING INSPECTOR"

Course Date: February 13, 2025

Examination Date: N/A

Certificate No.: Colorado Approved Live-Remote Course CO-BIR-25-1007

Hours Completed: ~ 4

Expiration Date: February 13, 2026

Michael Schluterbusch
Instructor – Michael Schluterbusch

Jorge Robles
Authorized Signature – Training Provider

Colorado Department
of Public Health
and Environment

ASBESTOS CONSULTING FIRM

This certifies that

Foothills Environmental a Division of SET Env Inc.

Registration No.: ACF - 14925

has met the registration requirements of 25-7-507, C.R.S. and the Air Quality Control Commission Regulation No. 8, Part B, and is hereby authorized to perform asbestos consulting activities as required under Regulation No 8, Part B, in the state of Colorado.

Issued: February 12, 2025
Expires: March 10, 2026

Authorized APCD Representative

SEAL

02 82 00AT3

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165 South Union Boulevard
Suite 310
Lakewood, CO 80228
303.988.2585
Fax 303.988.2583

15 February 2006

Mr. Chad Callan, CHMM
Toxics Program Manager
460th CES/CEV
660 South Aspen Street, Stop 86
Buckley Air Force Base, Colorado 80011-9551

Clayton Project No. 90-04152.01

Subject: **Facility Maintenance Plan – NONE REQUIRED**
Building 424
Buckley Air Force Base, Colorado 80011

Dear Mr. Callan:

The following report has been complied from bulk sampling and subsequent analysis of suspect asbestos containing building materials (ACBM) which were identified through visual inspections performed at Building 424 (hereafter, known as the "facility") located on Buckley Air Force Base (AFB), Colorado. Mr. T. Mark Suggs, state-licensed asbestos building inspector with Clayton Group Services, Inc. (Clayton) performed the assessment of suspect building materials on 18 July 2005.

The facility identified as Bldg. 424 was built in 2000. 460 CES personnel provided Clayton with access to and escorts in the facility while performing bulk sampling of suspect ACBM.

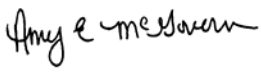
All accessible areas within the facility were inspected for suspect ACBM to include thermal systems insulation, surfacing materials, and miscellaneous materials (e.g., floor coverings, mastics and gaskets). When materials suspected of containing asbestos were located, representative samples were collected from each homogeneous material and forwarded for analysis.

Clayton collected a total of ten (10) bulk samples of suspect ACBM from five (5) homogeneous materials located within the facility. A tabular listing of materials sampled may be referenced in Atch 1; specific locations from where these samples were collected may be referenced in Atch 2.

None of the materials sampled during the course of this assessment showed any detectable quantities of asbestos under laboratory analysis.

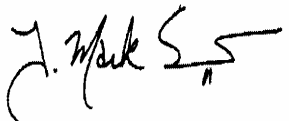
Since no ACBM within Bldg. 424 has been identified by a state-licensed inspector following the inspection protocol outlined in Colorado Regulation 8B, a maintenance plan is not currently required. **However, if hidden suspect building materials are encountered during routine operations, renovations, demolition or other activities which do not appear to be like materials previously sampled during the assessment of the facility, sampling and analysis of these materials by a state-certified inspector for the presence of asbestos should be done prior to disturbing the suspected materials.** Examples of these isolated locations include, but are not limited to wall cavities, pipe chases and under existing flooring (i.e.: sheet flooring products, carpet, sub-flooring). A list of suspect materials that may contain asbestos is provided in Atch 3.

Additional information concerning the discovery and management of ACBM within facilities may be referenced in the Buckley AFB Asbestos Operating Plan, dated 1 Sep 04.



This report submitted by: _____

Amy E. McGovern
Project Manager
CO Asbestos Building Inspector #12534



This report reviewed by: _____

T. Mark Suggs, REM, OHST
Program Manager
CO Asbestos Building Inspector #9966

15 February 2006

3 Atchs:

1. Summary of Asbestos Sample Results
2. Sampling Locations Diagram
3. Sample List of Suspect Asbestos-Containing Materials

ATTACHMENTS

Attachment 1

SUMMARY OF ASBESTOS SAMPLE RESULTS

Attachment 2

SAMPLING LOCATIONS DIAGRAM

Attachment 3

SAMPLE LIST OF SUSPECT ASBESTOS-CONTAINING MATERIALS

SAMPLE LIST OF SUSPECT ASBESTOS-CONTAINING MATERIALS

- Acoustical Plaster
- Adhesives
- Asphalt Floor Tile
- Base Flashing
- Blown-in Insulation
- Boiler Insulation
- Breaching Insulation
- Caulking/Putties
- Ceiling Tiles and Lay-in Panels
- Cement Pipes
- Cement Siding
- Cement Wallboard
- Chalkboards
- Construction Mastics (floor tile, carpet, ceiling tile, etc.)
- Cooling Towers
- Decorative Plaster
- Ductwork Flexible Fabric Connections
- Electrical Cloth
- Electrical Panel Partitions
- Electrical Wiring Insulation
- Elevator Brake Shoes
- Elevator Equipment Panels
- Fire Blankets
- Fire Curtains
- Fire Doors
- Fireproofing Materials
- Flooring Backing
- Heating and Electrical Ducts
- High Temperature Gaskets
- HVAC Duct Insulation
- Joint Compounds
- Laboratory Hoods/Table Tops
- Magnesite (Cementous type) Flooring
- Packing Materials (for wall/ floor penetrations)
- Pipe Insulation (corrugated air-cell, block, etc.)
- Roofing Felt
- Roofing Shingles
- Spackling Compounds
- Spray-Applied Insulation
- Taping Compounds (thermal)
- Textured Paints/Coatings
- Thermal Paper Products
- Vinyl Floor Tile
- Vinyl Sheet Flooring
- Vinyl Wall Coverings
- Wallboard

Note: This list does not include every product that may contain asbestos; nor is it a specific list of materials. It is intended as a general guide, primarily for training, to show which types of materials that may contain asbestos.

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SECTION 02 83 00

LEAD IN CONSTRUCTION
11/18

PART 1 GENERAL

Buildings 417, 423, and 424 are scheduled for demolition as part of this project. Available asbestos surveys are attached to specification section 02 82 00 ASBESTOS REMEDIATION. Lead-containing paint survey and survey of other hazardous materials for these buildings is not available. Prior to demolition, the Contractor shall obtain a hazardous materials survey (including asbestos survey, lead-containing paint survey and other hazardous materials) for these three buildings. The survey shall comply with applicable Federal and Colorado regulations. Where project activities to demolish the buildings will disturb or remove paint, follow appropriate procedures identified in this section. Ensure that workers are protected from any exposure to airborne lead particulate and that no loose paint or paint dust contaminates the surrounding area. Collect any lead paint waste generated when paint is disturbed or removed for proper disposal in accordance with this section and applicable regulations. Any metal items that are coated with lead-based paint may be disposed at a recycler authorized to recycle scrap metal, with notification to the recycler of the presence of lead paint.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.59	Hazard Communication
29 CFR 1926.62	Lead
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 268	Land Disposal Restrictions

UL SOLUTIONS (UL)

UL 586	(2009; Reprint Sep 2022) UL Standard for Safety High-Efficiency Particulate, Air Filter Units

1.2 DEFINITIONS

1.2.1 Action Level

Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8-hour period.

1.2.2 Area Sampling

Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel (approximately 5 to 6 feet above the floor).

1.2.3 Competent Person (CP)

As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of leadhazards in accordance with current federal, State, and local regulations and has the authority to take prompt corrective actions to control the lead hazard.

1.2.4 Eight-Hour Time Weighted Average (TWA)

Airborne concentration of lead to which an employee is exposed, averaged over an 8-hour workday as indicated in 29 CFR 1926.62.

1.2.5 High Efficiency Particulate Air (HEPA) Filter Equipment

HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead contaminated particulate. A high efficiency particulate filter demonstrates at least 99.97 percent efficiency against 0.3 micron or larger size particles.

1.2.6 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps. Excludes other forms of organic lead compounds.

1.2.7 Lead-Based Paint (LBP)

Paint or other surface coating that contains lead in excess of 1.0 milligrams per centimeter squared or 0.5 percent by weight.

1.2.8 Lead Control Area

A system of control methods to prevent the spread of lead dust, paint

chips or debris to adjacent areas that may include floor or ground cover protection, physical boundaries, and warning signs to prevent unauthorized entry of personnel.

1.2.9 Lead Permissible Exposure Limit (PEL)

Fifty micrograms per cubic meter of air as an 8-hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than 8-hours in a work day, determine the PEL by the following formula:

PEL (micrograms/cubic meter of air) = 400/No. hrs worked per day

1.2.10 Material Containing Lead/Paint with Lead (MCL/PWL)

Any material, including paint, which contains lead as determined by the testing laboratory using a valid test method.

1.2.11 Personal Sampling

Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples must be representative of the employees' work tasks. Breathing zone must be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and centered at the nose or mouth of an employee.

1.2.12 Physical Boundary

Area physically roped or partitioned off around lead control area to limit unauthorized entry of personnel.

1.3 DESCRIPTION

Construction activities impacting PWL or material containing lead which are covered by this specification include the disturbance, removal and disposal of items coated with lead-based paint, lead-based paint and lead-containing paint and any paint waste resulting from disturbance or demolition of painted surfaces. If existing paint is disturbed, flaking or deteriorated, ensure the collection and proper disposal of loose paint and associated debris. The work covered by this section includes work tasks and the precautions specified in this section for the protection of workers and the environment during and after the performance of the disturbance, removal and disposal activities.

1.3.1 Protection of Existing Areas To Remain

Project work including, but not limited to, lead hazard work, storage, transportation, and disposal must be performed without damaging or contaminating adjacent work and areas. Where such work or areas are damaged or contaminated, restore work and areas to the original condition.

1.3.2 Coordination with Other Work

Coordinate with work being performed in adjacent areas to ensure there are no exposure issues. Explain coordination procedures in the Lead Compliance Plan and describe how the Contractor will prevent lead exposure to other contractors and Government personnel performing work unrelated to lead activities.

1.3.3 Sampling and Analysis

Submit a log of the analytical results from any sampling conducted during the abatement. Keep the log of results current with project activities and brief the results to the Contracting Officer as analytical results are reported.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Lead Waste Management Plan; G, RO

Lead Compliance Plan; G, ROMaterials and Equipment; G, RO
Expendable Supplies; G, RO
Sampling and Analysis; G, RO

SD-11 Closeout Submittals

Hazardous Waste Manifest; G, RO

Turn-In Documents or Weight Tickets; G, RO

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

1.5.1.1 Competent Person (CP)

The Competent Person shall have construction project-related experience which shows ability to assess occupational and environmental exposure to lead and exposure reduction methods to protect employee health.

1.5.2 Requirements

1.5.2.1 Competent Person (CP) Responsibilities

a. Verify training meets all federal, State, and local requirements.

b. Review and approve Lead Waste Management Plan and Lead Compliance Plan for conformance to the applicable referenced standards.

c. Continuously inspect LBP/PWL or MCL work for conformance with the approved plan.

d. Perform (or oversee performance of) any personal air sampling required by the approved Lead Compliance Plan.

e. Ensure work is performed in strict accordance with specifications at all times.

f. Control work to prevent hazardous exposure to human beings and to the environment at all times.

1.5.2.2 Lead Compliance Plan

Submit a job-specific plan of the work procedures to be used in the disturbance of lead, LBP/PWL or MCL. Include in the plan a description identifying the location(s), size, and details of lead control areas, physical boundaries, location and details of decontamination facilities, as appropriate to the work. Include a description of equipment and materials, work practices, controls and job responsibilities for each activity from which lead is emitted. Include in the plan all requirements appropriate to the work, such as eating, drinking, smoking, hygiene facilities and sanitary procedures, collected waste water and dust containing lead and debris, air sampling, respirators, personal protective equipment, and a detailed description of the method of control of the operation to ensure that leadis not released outside of the lead control area.

1.5.2.3 Hazard Communication Program

Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.

1.5.2.4 Lead Waste Management

The LeadWaste Management Plan must comply with applicable requirements of federal, State, and local hazardous waste regulations and address:

a. Identification and classification of wastes associated with the work.

b. Names and qualifications of each contractor that will be disposing of the wastes. Include the facility location and a 24-hour point of contact.

c. List of waste handling equipment to be used in performing the work, to include cleaning and transport equipment.

d. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented.

e. Work plan and schedule for waste removal and disposal. Clean up wastes daily.

1.5.2.5 Environmental, Safety and Health Compliance

In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of federal, State, and local authorities regarding lead. Comply with the applicable requirements of the current issue of 29 CFR 1926.62, and EM 385-1-1.

1.5.3 Pre-Construction Conference

Along with the CP, meet with the Contracting Officer to discuss in detail the Lead Waste Management Plan and the Lead Compliance Plan, including procedures and precautions for the work.

1.6 EQUIPMENT

1.6.1 Respirators

Furnish appropriate respirators approved by the National Institute for

Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust, fume and mist. Respirators must comply with the requirements of 29 CFR 1926.62.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Protection of Existing Work to Remain

Perform work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better as determined by the Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Keep materials and equipment needed to complete the project available and on the site. Submit a description of the materials and equipment required; including Safety Data Sheets (SDSs) for material brought onsite to perform the work.2.1.1 Expendable Supplies

Submit a description of the expendable supplies required.

2.1.1.1 Detergents and Cleaners

Detergents or cleaning agents must not contain trisodium phosphate and have demonstrated effectiveness in lead control work.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

3.1.1.1 Lead Control Area

a. Physical Boundary - Provide physical boundaries around the lead control area by roping off the area designated in the work plan to ensure that lead will not escape outside of the lead control area.

3.1.1.2 Eye Wash Station

Provide suitable facilities within the work area for quick drenching or flushing of the eyes where eyes may be exposed to injurious corrosive materials.

3.1.1.3 Personnel Protection

Personnel must wear and use protective clothing and equipment as specified in the approved Lead Compliance Plan. Eating, smoking, or drinking or application of cosmetics is not permitted in the leadcontrol area. No one will be permitted in the leadcontrol area unless they have been appropriately trained and provided with protective equipment.

3.2 APPLICATION

3.2.1 Lead Work

Perform lead work in accordance with approved Lead Compliance Plan. Use

procedures and equipment required to limit occupational exposure and environmental contamination with lead when the work is performed in accordance with 29 CFR 1926.62 and as specified herein. Dispose of all PWL or MCL and associated waste in compliance with federal, State, and local requirements.

3.2.2 Paint with Lead Removal

Manual or power sanding or grinding of lead surfaces or materials is not permitted unless tools are equipped with HEPA attachments or wet methods. The dry sanding or grinding of surfaces that contain lead is prohibited. If it is elected to remove lead-containing paint as preparation for demolition work, provide methodology for removing lead in the Lead Compliance Plan. Select lead removal processes to minimize contamination of work areas outside the control area with lead contaminated dust or other lead contaminated debris or waste and to ensure that unprotected personnel are not exposed to hazardous concentrations of lead. Describe this removal process in the Lead Compliance Plan.

3.3 FIELD QUALITY CONTROL

3.3.1 Tests

3.3.1.1 Air Sampling

If required by the approved Lead Compliance Plan, conduct sampling for lead in accordance with 29 CFR 1926.62. Air sampling must be directed or performed by the CP.

a. If personal air samples are required, collect personal air samples on employees who are anticipated to have the greatest risk of exposure as determined by the CP.

b. Submit results of air samples, signed by the CP, within 72-hours after the air samples are taken.

3.3.1.2 Testing of Material Containing Lead Residue

Test residue in accordance with 40 CFR 261 for hazardous waste.

3.4 CLEANING AND DISPOSAL

3.4.1 Cleanup

Maintain surfaces of the lead control area free of accumulations of dust and debris. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use pressurized air to clean up the area.

3.4.2 Disposal

a. Dispose of material, whether hazardous or non-hazardous in accordance with all laws and provisions and all federal, State or local regulations. Ensure all waste is properly characterized. The result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.

b. Contractor is responsible for segregation of waste. Collect lead contaminated waste, scrap, debris, bags, containers, equipment, and

any lead contaminated clothing that may produce airborne concentrations of lead particles. For any potential hazardous waste such as loose paint, label the containers in accordance with 29 CFR 1926.62, and 40 CFR 261, 40 CFR 262 and corresponding state regulations.

c. Dispose of lead contaminated material classified as hazardous waste at an EPA or State approved hazardous waste treatment, storage, or disposal facility off Government property.

d. Handle, store, transport, and dispose lead or lead contaminated waste that is considered to be hazardous in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.

e. All lead waste generation, management,and disposal will be coordinated with the USACE KO and facility environmental coordinator.

3.4.2.1 Disposal Documentation

Coordinate all disposal or off-site shipments of lead waste with the USACE KO and facility environmental coordinator. If any waste is considered hazardous, submit one copy of the completed hazardous waste manifest, signed and dated by the initial transporter in acdance with 40 CFR 262. Provide a certificate that the waste was accepted by the disposal facility. Provide turn-in documents or weight tickets for non-hazardous waste disposal.

-- End of Section --

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SECTION 02 84 16

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11/22

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SECTION 02 84 16

HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBs AND MERCURY
11/22

PART 1 GENERAL

The Contractor shall review Buildings 417, 423, and 424 prior to demolition activities for lighting ballasts that may contain PCBs and lamps that are anticipated to contain mercury. See also section 02 82 00 Asbestos Remediation for requirement to perform a hazardous materials survey. Handle and dispose of these materials prior to demolition in accordance with this specification and applicable regulations. Coordinate disposal of such materials with USACE and the facility environmental coordinator.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 270	EPA Administered Permit Programs: The Hazardous Waste Permit Program
40 CFR 273	Standards for Universal Waste Management
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 178	Specifications for Packagings

1.2 REQUIREMENTS

Removal and disposal of PCB containing lighting ballasts and associated mercury-containing lamps. Contractor may encounter leaking PCB ballasts.

1.3 DEFINITIONS

1.3.1 Leak

Leak or leaking means any instance in which a PCB article, PCB container, or PCB equipment has any PCBs on any portion of its external surface.

1.3.2 Lamps

Lamp is defined as the bulb or tube portion of an electric lighting device. A lamp is specifically designed to produce radiant energy, most often in the ultraviolet, visible, and infra-red regions of the electromagnetic spectrum. Examples of common electric lamps include, but are not limited to, fluorescent, high intensity discharge, neon, mercury vapor, high pressure sodium, and metal halide lamps.

1.3.3 Polychlorinated Biphenyls (PCBs)

PCBs as used in this specification mean the same as PCBs, and all related items, as defined in 40 CFR 761, Section 3, Definitions.

1.3.4 Spill

Spill means both intentional and unintentional spills, leaks, and other uncontrolled discharges when the release results in any quantity of PCBs running off or about to run off the external surface of the equipment or other PCB source, as well as the contamination resulting from those releases.

1.3.5 Universal Waste

Universal Waste means any of the following hazardous wastes that are managed under the universal waste requirements 40 CFR 273:

(1) Batteries as described in Sec. 273.2 of this chapter;

(2) Pesticides as described in Sec. 273.3 of this chapter;

(3) Mercury containing equipment as described in Sec. 273.4 of this chapter; and

(4) Lamps as described in Sec. 273.5 of this chapter.

1.4 QUALITY ASSURANCE

1.4.1 Regulatory Requirements

Perform PCB related work in accordance with 40 CFR 761. Perform mercury-containing lamps storage and transport in accordance with 40 CFR 261, 40 CFR 264, 40 CFR 265, 40 CFR 273.

1.4.2 Training

Instruction and certification of training of all persons involved in the removal of PCB containing lighting ballasts and mercury-containing lamps is the responsibility of the Contractor. Include in the instruction: The dangers of PCB and mercury exposure, decontamination, safe work practices, and applicable OSHA and EPA regulations. The Contractor must review and approve the PCB and Mercury-Containing Lamp Removal Work Plans.

1.4.3 Regulation Documents

Maintain at all times one copy each at the office and one copy each in view at the job site of 29 CFR 1910.1000, 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 265, 40 CFR 268, 40 CFR 270, 40 CFR 273 and of the Contractor removal work plan and disposal plan for PCB and for associated mercury-containing lamps.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

PCB and Lamp Removal Work Plan; G, RO

PCB and Lamp Disposal Plan; G, RO

SD-11 Closeout Submittals

Transporter Certification of notification to EPA of their PCB waste activities and EPA ID numbers; G, RO

Certification of Decontamination

Certificate of Disposal and/or recycling. Submit to the Government before application for payment within 30 days of the date that the disposal of the PCB and mercury-containing lamp waste identified on the manifest was completed.

1.6 ENVIRONMENTAL REQUIREMENTS

Use special clothing:

a. Disposable gloves (polyethylene)

b. Eye protection

c. PPE as required by the approved plans

1.7 SCHEDULING

Notify the Contracting Officer 20 days prior to the start of PCB and mercury-containing lamp removal work.

1.8 QUALITY ASSURANCE

1.8.1 PCB and Lamp Removal Work Plan

Submit a job-specific plan within 20 calendar days after award of contract of the work procedures to be used in the removal, packaging, and storage of PCB-containing lighting ballasts and associated mercury-containing lamps. Include in the plan: Requirements for Personal Protective Equipment (PPE), spill cleanup procedures and equipment, eating, smoking and restroom procedures. The plan must be approved and signed by the Contractor. Obtain approval of the plan by the Contracting Officer prior to the start of PCB and/or lamp removal work.

1.8.2 PCB and Lamp Disposal Plan

Submit a PCB and lamp Disposal Plan within 45 calendar days after award of contract, complying with the applicable requirements of federal, state, and local PCB and Universal waste regulations and address:

a. Estimated quantities of wastes to be generated, disposed of, and recycled.

b. Names and qualifications of each Contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location. Furnish copies of EPA and state PCB and mercury-containing lamp waste permit applications and EPA identification numbers, as required.

c. Names and qualifications (experience and training) of personnel who will be working on-site with PCB and mercury-containing lamp wastes.

d. Spill prevention, containment, and cleanup contingency measures to be implemented.

e. Work plan and schedule for PCB and mercury-containing lamp waste removal, containment, storage, transportation, disposal and or recycling. Clean up and containerize wastes daily.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 WORK PROCEDURE

Furnish labor, materials, services, and equipment necessary for the removal of PCB containing lighting ballasts, associated mercury-containing fluorescent lamps, and high intensity discharge (HID) lamps in accordance with local, state, or federal regulations. Do not expose PCBs to open flames or other high temperature sources since toxic decomposition by-products may be produced. Do not break mercury containing fluorescent lamps or high intensity discharge lamps.

3.1.1 Work Operations

Ensure that work operations or processes involving PCB or PCB-contaminated materials are conducted in accordance with 40 CFR 761, 40 CFR 262 40 CFR 263, and the applicable requirements of this section, including but

not limited to:

a. Obtaining suitable PCB and mercury-containing lamp storage sites.

b. Notifying Contracting Officer prior to commencing the operation.

c. Reporting leaks and spills to the Contracting Officer.

d. Cleaning up spills.

e. Inspecting PCB and PCB-contaminated items and waste containers for leaks and forwarding copies of inspection reports to the Contracting Officer.

f. Maintaining inspection, inventory and spill records.

3.2 PCB SPILL CLEANUP REQUIREMENTS

3.2.1 PCB Spills

Immediately report to the Contracting Officer any PCB spills.

3.2.2 PCB Spill Control Area

Rope off an area around the edges of a PCB leak or spill and post a "PCB Spill Authorized Personnel Only" caution sign. Immediately transfer leaking items to a drip pan or other container.

3.2.3 PCB Spill Cleanup

40 CFR 761, subpart G. Initiate cleanup of spills as soon as possible, but no later than 24 hours of its discovery. Mop up the liquid with rags or other conventional absorbent. Properly contain and dispose of spent absorbent as solid PCB waste.

3.2.4 Records and Certification

Document the cleanup with records of decontamination in accordance with 40 CFR 761, Section 125, Requirements for PCB Spill Cleanup. Provide test results of cleanup and certification of decontamination.

3.3 REMOVAL

3.3.1 Ballasts

As ballast are removed from the lighting fixture, inspect label on ballast. Ballasts without a "No PCB" label must be assumed to contain PCBs and containerized and disposed of as required under paragraphs STORAGE FOR DISPOSAL and DISPOSAL. If there are less than 1600 "No PCB" labeled lighting ballasts, dispose of them as normal demolition debris.

3.3.2 Lighting Lamps

Remove lighting tubes/lamps from the lighting fixture and carefully place (unbroken) into appropriate containers (original transport boxes or equivalent). In the event of a lighting tube/lamp breaking, sweep and place waste in double plastic taped bags and dispose of as universal waste as specified herein.

3.4 STORAGE FOR DISPOSAL

3.4.1 Storage Containers for PCBs

49 CFR 178. Store PCB in containers approved by DOT for PCB.

3.4.2 Storage Containers for lamps

Store mercury containing lamps in appropriate DOT containers. Store and label boxes for transport in accordance with 40 CFR 273.

3.4.3 Labeling of Waste Containers

Label with the following:

a. Date the item was placed in storage and the name of the cognizant activity/building.

b. "Caution Contains PCB," conforming to 40 CFR 761, CFR Subpart C. Affix labels to PCB waste containers.

c. Label mercury-containing lamp waste in accordance with 40 CFR 273. Affix labels to all lighting waste containers.

3.5 DISPOSAL

Dispose of off Government property in accordance with EPA, DOT, and local regulations at a permitted site.

3.5.1 Identification Number

Federal regulations 40 CFR 761, and 40 CFR 263 require that generators, transporters, commercial storers, and disposers of PCB waste posses U.S. EPA identification numbers. Verify that the activity has a U.S. EPA generator identification number for use on the Uniform Hazardous Waste manifest. If not, advise the activity that it must file and obtain an I.D. number with EPA prior to commencement of removal work. For mercury containing lamp removal, Federal regulations 40 CFR 273 require that large quantity handlers of Universal waste (LQHUW) must provide notification of universal waste management to the appropriate EPA Region (or state director in authorized states), obtain an EPA identification number, and retain for three years records of off-site shipments of universal waste. Verify that the activity has a U.S. EPA generator identification number for use on the Universal Waste manifest. If not, advise the activity that it must file and obtain an I.D. number with EPA prior to commencement of removal work.

3.5.2 Transporter Certification

Comply with disposal and transportation requirements outlined in 40 CFR 761 and 40 CFR 263. Before transporting the PCB waste, sign and date the manifest acknowledging acceptance of the PCB waste from the Government. Return a signed copy to the Government before leaving the job site. Ensure that the manifest accompanies the PCB waste at all times. Submit transporter certification of notification to EPA of their PCB waste activities (EPA Form 7710-53).

3.5.2.1 Certificate of Disposal and/or Recycling

40 CFR 761. Include in the certificate for the PCBs and PCB items disposed:

a. The identity of the disposal and or recycling facility, by name, address, and EPA identification number.

b. The identity of the PCB waste affected by the Certificate of Disposal including reference to the manifest number for the shipment.

c. A statement certifying the fact of disposal and or recycling of the identified PCB waste, including the date(s) of disposal, and identifying the disposal process used.

d. A certification as defined in 40 CFR 761.

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DIVISION 03 - CONCRETE

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CAST-IN-PLACE CONCRETE

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; R 2015) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 121R	(2008) Guide for Concrete Construction Quality Systems in Conformance with ISO 9001
ACI 301	(2020) Specifications for Structural Concrete
ACI 302.1R	(2015) Guide for Concrete Floor and Slab Construction
ACI 304.2R	(2017) Guide to Placing Concrete by Pumping Methods
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 308.1	(2023) Specification for Curing Concrete
ACI SP-2	(2007; Abstract: 10th Edition) ACI Manual of Concrete Inspection
ACI SP-15	(2011) Field Reference Manual: Standard Specifications for Structural Concrete ACI 301-05 with Selected ACI References

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A184/A184M	(2019) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A706/A706M	(2024) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A884/A884M	(2019; Errata 1) Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934/A934M	(2022) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A970/A970M	(2018) Standard Specification for Headed Steel Bars for Concrete Reinforcement
ASTM A1022/A1022M	(2016b) Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement
ASTM A1044/A1044M	(2016a; Errata 1) Standard Specification for Steel Stud Assemblies for Shear Reinforcement of Concrete
ASTM A1060/A1060M	(2016b) Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1064/A1064M	(2022) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024b) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2023) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical

	Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C125	(2021a) Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2022) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C311/C311M	(2024) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C330/C330M	(2017a) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C803/C803M	(2023) Standard Test Method for Penetration Resistance of Hardened Concrete

ASTM C845/C845M	(2018) Standard Specification for Expansive Hydraulic Cement
ASTM C873/C873M	(2015) Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds
ASTM C900	(2015) Standard Test Method for Pullout Strength of Hardened Concrete
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C989/C989M	(2022) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1012/C1012M	(2024) Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1074	(2019; E 2021) Standard Practice for Estimating Concrete Strength by the Maturity Method
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1293	(2008; R 2015) Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1778	(2023) Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D2628	(1991; R 2016) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D2835	(1989; R 2017) Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
ASTM D3042	(2017) Standard Test Method for Insoluble Residue in Carbonate Aggregates
ASTM D5759	(2012; R 2020) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM D6690	(2021) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E1643	(2018a) Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
ASTM E1745	(2017; R 2023) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2018; Errata 2019) Manual of Standard Practice
CRSI RB4.1	(2016) Supports for Reinforcement Used in Concrete

FOREST STEWARDSHIP COUNCIL (FSC)

FSC STD 01 001	(2015) Principles and Criteria for Forest Stewardship

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1	(2009) DOC Voluntary Product Standard PS 1-07, Structural Plywood

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC	(2013) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 DEFINITIONS

a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, slag cement.

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Supplementary cementing materials" (SCM) include coal fly ash, slag cement, natural or calcined pozzolans, and ultra-fine coal ash when used in such proportions to replace the portland cement that result in improvement to sustainability and durability and reduced cost.

e. "Design strength" (f'c) is the specified compressive strength of concrete at time(s) specified in this section to meet structural design criteria.

f. "Mass Concrete" is any concrete system that approaches a maximum temperature of 158 degrees F within the first 72 hours of placement. In addition, it includes all concrete elements with a section thickness of 3 feet or more regardless of temperature.

g. "Mixture proportioning" is the process of designing concrete mixture proportions to enable it to meet the strength, service life and constructability requirements of the project while minimizing the initial and life-cycle cost.

h. "Mixture proportions" are the masses or volumes of individual ingredients used to make a unit measure (cubic meter or cubic yard) of concrete.

i. "Pozzolan" is a siliceous or siliceous and aluminous material, which

in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

j. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

h. "Nominal Maximum Aggregate Size" is defined in ASTM C125 as the smallest sieve opening through which the entire amount of aggregate is permitted but not required to pass.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Program; G, RO

Quality Control Personnel Certifications; G, RO

Quality Control Organizational Chart

Laboratory Accreditation; G, RO

Maturity Method Data

SD-02 Shop Drawings

Reinforcing Steel; G, DO

SD-03 Product Data

Joint Sealants;

Joint Filler;

Formwork Materials

Recycled Aggregate Materials;

Cementitious Materials;

Vapor Barrier

Concrete Curing Materials

Reinforcement;

Liquid Chemical Floor Hardeners and Sealers

Admixtures

Mechanical Reinforcing Bar Connectors

Local/Regional Materials;

Biodegradable Form Release Agent

Nonshrink Grout

SD-05 Design Data

Concrete Mix Design; G,DO

SD-06 Test Reports

Concrete Mix Design; G,DO

Fly Ash

Pozzolan

Slag Cement

Aggregates

Compressive Strength Tests; G,DO
Slump Tests

Water

SD-07 Certificates

Reinforcing Bars

Welder Qualifications

Forest Stewardship Council (FSC) Certification

Field Testing Technician and Testing Agency

SD-08 Manufacturer's Instructions

Liquid Chemical Floor Hardeners and Sealers

Joint Sealants; (LEED NC)

Curing Compound

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Follow ACI 301, ACI 304R and ASTM A934/A934M requirements and recommendations. Do not deliver concrete until vapor retarder, vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Design Data

1.6.1.1 Concrete Mix Design

Sixty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, supplementary cementitious materials, and admixtures; and applicable reference specifications. Submit mill test and all other test for cement, supplementary cementitious materials, aggregates, and admixtures. Provide documentation of maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Resubmit data on concrete components if the qualities or source of components changes. Required average strength can be documented by field experience if field strength test data are available and represent a single group of at least 10 consecutive strength tests for one mixture, using materials and conditions similar to those expected for work, and encompassing a period of not less than 45 days. The average of field strength tests shall equal or exceed fcr'. Changes in materials, conditions, and proportions within the test record shall not have been more closely restricted than those for the proposed work. Test records shall not be more than 24 months old. Obtain mix design approval from the contracting officer prior to concrete placement.

1.6.2 Shop Drawings

1.6.2.1 Reinforcing Steel

Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Reproductions of contract drawings are unacceptable. Note adjustments required to coordinate the vertical routing of conduits, ductbanks, and water pipes on the coordinated submittals package delivered for this item.

1.6.3 Test Reports

1.6.3.1 Fly Ash and Pozzolan

Submit test results in accordance with ASTM C618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date.

1.6.3.2 Slag Cement

Submit test results in accordance with ASTM C989/C989M for slag cement. Submit test results performed within 6 months of submittal date.

1.6.3.3 Aggregates

Submit test results in accordance with ASTM C33/C33M, or ASTM C330/C330M for lightweight aggregate, and ASTM C1293 or ASTM C1567 as required in the paragraph titled ALKALI-AGGREGATE REACTION.

1.6.4 Quality Control Program

Develop and submit for approval a concrete quality control program in accordance with the guidelines of ACI 121R and as specified herein. The plan must include approved laboratories. Provide direct oversight for the concrete qualification program inclusive of associated sampling and testing. All quality control reports must be provided to the Contracting Officer, Quality Manager and Concrete Supplier. Maintain a copy of ACI SP-15 and CRSI 10MSP at project site.

1.6.5 Quality Control Personnel Certifications

The Contractor must submit for approval the responsibilities of the various quality control personnel, including the names and qualifications of the individuals in those positions and a quality control organizational chart defining the quality control hierarchy and the responsibility of the various positions. Quality control personnel must be employed by the Contractor.

Submit American Concrete Institute certification for the following:

a. CQC personnel responsible for inspection of concrete operations.

b. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews.

c. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

1.6.5.1 Quality Manager Qualifications

The quality manager must hold a current license as a professional engineer in a U.S. state or territory with experience on at least five similar projects. Evidence of extraordinary proven experience may be considered by the Contracting Officer as sufficient to act as the Quality Manager.

1.6.5.2 Field Testing Technician and Testing Agency

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing testing on concrete.

a. Work on concrete under this contract must be performed by an ACI Concrete Field Testing Technician Grade 1 qualified in accordance with ACI SP-2 or equivalent. Equivalent certification programs must include requirements for written and performance examinations as stipulated in ACI SP-2.

b. Testing agencies that perform testing services on reinforcing steel must meet the requirements of ASTM E329.

c. Testing agencies that perform testing services on concrete materials must meet the requirements of ASTM C1077.

1.6.6 Laboratory Qualifications for Concrete Qualification Testing

The concrete testing laboratory must have the necessary equipment and experience to accomplish required testing. The laboratory must meet the requirements of ASTM C1077 and be Cement and Concrete Reference Laboratory (CCRL) inspected.

1.6.7 Laboratory Accreditation

Laboratory and testing facilities must be provided by and at the expense of the Contractor. The laboratories performing the tests must be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation must be current and must include the required test methods, as specified. Furthermore, the testing must comply with the following requirements:

a. Aggregate Testing and Mix Proportioning: Aggregate testing and mixture proportioning studies must be performed by an accredited laboratory and under the direction of a registered professional engineer in a U.S. state or territory competent in concrete materials who is competent in concrete materials and must sign all reports and designs.

b. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M.

c. Contractor Quality Control: All sampling and testing must be performed by an approved, onsite, independent, accredited laboratory.

1.7 ENVIRONMENTAL REQUIREMENTS

Provide space ventilation according to material manufacturer recommendations, at a minimum, during and following installation of concrete curing compound and sealer. Maintain one of the following ventilation conditions during the curing period or for 72 hours after installation:

a. Supply 100 percent outside air 24 hours a day.

b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 84 degrees F and humidity is between 30 percent and 60 percent.

c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

1.7.1 Submittals for Environmental Performance

a. Provide data indication the percentage of post-industrial pozzolan (fly ash, slag cement) cement substitution as a percentage of the full product composite by weight.

b. Provide data indicating the percentage of post-industrial and post-consumer recycled content aggregate.

c. Provide product data indicating the percentage of post-consumer recycled steel content in each type of steel reinforcement as a percentage of the full product composite by weight.

d. Provide product data stating the location where all products were manufactured

e. For projects using FSC certified formwork, provide chain-of-custody documentation for all certified wood products.

f. For projects using reusable formwork, provide data showing how formwork is reused.

g. Provide SDS product information data showing that form release agents meet any environmental performance goals such as using vegetable and soy based products.

h. Provide SDS product information data showing that concrete adhesives meet any environmental performance goals including low emitting, low volatile organic compound products.

1.8 SUSTAINABLE DESIGN REQUIREMENTS

1.8.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total local material requirements. Concrete materials may be locally available. Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total

dollar value of products included in project.

1.8.2 Forest Stewardship Council (FSC) Certification

Use FSC-certified wood where specified. Provide letter of certification signed by lumber supplier. Indicate compliance with FSC STD 01 001 and identify certifying organization. Submit FSC certification numbers; identify each certified product on a line-item basis. Submit copies of invoices bearing the FSC certification numbers.

1.9 QUALIFICATIONS FOR WELDING WORK

Welding procedures must be in accordance with AWS D1.4/D1.4M.

Verify that Welder qualifications are in accordance with AWS D1.4/D1.4M for welding of reinforcement or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

PART 2 PRODUCTS

2.1 FORMWORK MATERIALS

a. Form-facing material in contact with concrete must be lumber, plywood, tempered concrete-form-grade hardboard, metal,. Submit product information on proposed form-facing materials if different from that specified herein.

b. Design formwork, shores, reshores, and backshores to support loads transmitted to them and to comply with applicable building code requirements.

c. Design formwork and shoring for load redistribution resulting from stressing of post-tensioned reinforcement. Ensure that formwork allows movement resulting from application of prestressing force.

d. Design formwork to withstand pressure resulting from placement and vibration of concrete and to maintain specified tolerances.

e. Design formwork to accommodate waterstop materials in joints at locations indicated in Contract Documents.

f. Provide temporary openings in formwork if needed to facilitate cleaning and inspection.

g. Design formwork joints to inhibit leakage of mortar.

h. Limit deflection of facing materials for concrete surfaces exposed to view to 1/240 of center-to-center spacing of facing supports.

j. Submit product information on proposed form-facing materials if different from that specified herein.

m. Submit procedure for reshoring and backshoring, including drawings signed and sealed by a licensed design engineer. Include on shop drawings the formwork removal procedure and magnitude of construction loads used for design of reshoring or backshoring system. Indicate in procedure the magnitude of live and dead loads assumed for required capacity of the structure at time of reshoring or backshoring.

n. Submit manufacturer's product data on form liner proposed for use with each formed surface.

2.1.1 Wood Forms

Use lumber as specified in Section 06 10 00 ROUGH CARPENTRY and as follows. Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with NIST PS 1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining.

2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)

Provide plywood that conforms to NIST PS 1, B-B, high density form overlay, not less than 5/8-inch thick.

2.1.2 Plastic Forms

Plastic lumber as specified in Section 06 10 00 ROUGH CARPENTRY. Provide plastic forms that contain a minimum of 50 percent post-consumer recycled content, or a minimum of 50 percent post-industrial recycled content.

2.1.3 Steel Forms

Provide steel form surfaces that do not contain irregularities, dents, or sags.

2.2 FORMWORK ACCESSORIES

a. Use commercially manufactured formwork accessories, including ties and hangers.

b. Form ties and accessories must not reduce the effective cover of the reinforcement.

2.2.1 Form Ties

a. Use form ties with ends or end fasteners that can be removed without damage to concrete.

b. Where indicated in Contract Documents, use form ties with integral water barrier plates or other acceptable positive water barriers in walls.

c. The breakback distance for ferrous ties must be at least 1.0 in. for Surface Finish-2.0 or Surface Finish-3.0, as defined in ACI 301.

d. If the breakback distance is less than 3/4 in., use coated or corrosion-resistant ties.

e. Submit manufacturer's data sheet on form ties.

2.2.2 Biodegradable Form Release Agent

a. Provide form release agent that is colorless, biodegradable, , with a low (maximum of 55 grams/liter (g/l)) VOC content. A minimum of 85 percent of the total product must be biobased material.

b. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

c. Provide form release agent that reduces formwork moisture absorption, and does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene. Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.

d. Submit manufacturer's product data on formwork release agent for use on each form-facing material.

2.2.3 Chamfer Materials

Use lumber materials with dimensions of 3/4 x 3/4 in.

2.2.4 Construction and movement joints

a. Submit details and locations of construction joints in accordance with the requirements herein.

b. Locate construction joints within middle one-third of spans of slabs, beams, and girders. If a beam intersects a girder within the middle one-third of girder span, the distance between the construction joint in the girder and the edge of the beam must be at least twice the width of the larger member.

c. For members with post-tensioning tendons, locate construction joints where tendons pass through centroid of concrete section.

d. Locate construction joints in walls and columns at underside of slabs, beams, or girders and at tops of footings or slabs.

e. Make construction joints perpendicular to main reinforcement.

f. Provide movement joints where indicated in Contract Documents or in accepted alternate locations.

g. Submit location and detail of movement joints if different from those indicated in Contract Documents.

h. Submit manufacturer's data sheet on expansion joint materials.

i. Provide keyways where indicated in Contract Documents.

2.2.5 Other Embedded items

Use sleeves, inserts, anchors, and other embedded items of material and design indicated in Contract Documents.

2.3 CONCRETE MATERIALS

2.3.1 Cementitious Materials

2.3.1.1 Portland Cement

a. Unless otherwise specified, provide cement that conforms to ASTM C150/C150M Type II .

b. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

c. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch.Supplier must certify that no hazardous waste is used in the fuel mix or raw materials.

d. Submit information along with evidence demonstrating compliance with referenced standards. Submittals must include types of cementitious materials, manufacturing locations, shipping locations, and certificates showing compliance.

e. Cementitious materials must be stored and kept dry and free from contaminants.

2.3.1.2 Blended Cements

a. Blended cements must conform to ASTM C595/C595M Type IP,IS and IL or ASTM C1157/C1157M Type GU .

b. Slag cement added to the Type IS blend must meet ASTM C989/C989M.

c. The pozzolan added to the Type IP blend must meet ASTM C618 Class F,or Class C, and must be interground with the cement clinker. The manufacturer must state in writing that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. The percentage and type of pozzolan used in the blend must not change from that submitted for the aggregate evaluation and mixture proportioning.

2.3.1.3 Fly Ash

a. ASTM C618, Class F , except that the maximum allowable loss on ignition must not exceed 6 percent.

b. If fly ash is used it shall range from 15 to 35 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level,it shall not be used. Report the chemical analysis of the fly ash in accordance with ASTM C311/C311M. Evaluate and classify fly ash in accordance with ASTM D5759.

2.3.1.4 Slag Cement

ASTM C989/C989M, Grade 100.

2.3.1.5 Other Supplementary Cementitious Materials

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirement for uniformity.

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.

b. The average particle size must not exceed 6 microns.

c. The sum of SiO_2 plus Al_2O_3 plus Fe_2O_3 must be greater than 77 percent.

2.3.2 Water

a. Water or ice must comply with the requirements of ASTM C1602/C1602M.

b. Minimize the amount of water in the mix. Improve workability by adjusting the grading of the aggregate and using admixture rather than by adding water.

c. Water must be potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

d. Protect mixing water and ice from contamination during storage and delivery.

e. Submit test report showing water complies with ASTM C1602/C1602M.

2.3.3 Aggregate

2.3.3.1 Normal-Weight Aggregate

a. Aggregates must conform to ASTM C33/C33M .

b. Aggregates used in concrete must be obtained from the same sources and have the same size range as aggregates used in concrete represented by submitted field test records or used in trial mixtures.

c. Provide sand that is at least 50 percent acid insoluble based on ASTM D3042.

d. Store and handle aggregate in a manner that will avoid segregation and prevents contamination by other materials or other sizes of aggregates. Store aggregates in locations that will permit them to drain freely. Do not use aggregates that contain frozen lumps.

e. Submit types, pit or quarry locations, producers' names, aggregate supplier statement of compliance with ASTM C33/C33M, and ASTM C1293 expansion data not more than 18 months old.

2.3.3.2 Lightweight Aggregate

Lightweight aggregate in accordance with ASTM C330/C330M.

2.3.3.3 Recycled Aggregate Materials

Use a minimum of 25 percent recycled aggregate, depending on local availability and conforming to requirements of the mix design. Recycled aggregate to include: recovered concrete recovered stone that meets the aggregate requirements specified. Submit recycled material request with the aggregate certification submittals and do not use until approved by the Contracting Officer.

2.3.4 Admixtures

a. Chemical admixtures must conform to ASTM C494/C494M.

b. Air-entraining admixtures must conform to ASTM C260/C260M.

c. Chemical admixtures for use in producing flowing concrete must conform to ASTM C1017/C1017M.

d. Do not use calcium chloride admixtures.

e. Admixtures used in concrete must be the same as those used in the concrete represented by submitted field test records or used in trial mixtures.

f. Protect stored admixtures against contamination, evaporation, or damage.

g. To ensure uniform distribution of constituents, provide agitating equipment for admixtures used in the form of suspensions or unstable solutions. Protect liquid admixtures from freezing and from temperature changes that would adversely affect their characteristics.

h. Submit types, brand names, producers' names, manufacturer's technical data sheets, and certificates showing compliance with standards required herein.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Concrete Curing Materials

Provide concrete curing material in accordance with ACI 301 Section 5 and ACI 308.1 Section 2. Submit product data for concrete curing compounds. Submit manufactures instructions for placement of curing compound.

2.4.2 Nonshrink Grout

Nonshrink grout in accordance with ASTM C1107/C1107M.

2.4.3 Floor Finish Materials

2.4.3.1 Liquid Chemical Floor Hardeners and Sealers

a. Hardener must be a colorless aqueous solution containing a blend of inorganic silicate or siliconate material and proprietary components combined with a wetting agent; that penetrates, hardens, and densifies concrete surfaces. Submit manufactures instructions for placement of liquid chemical floor hardener.

b. Use concrete penetrating sealers with a low (maximum 100 grams/liter,

less water and less exempt compounds) VOC content. Submit manufactures instructions for placement of sealers.

2.4.3.2 Aggregate for Heavy-Duty Floor Topping

Provide emery (or may be traprock or traprock-screenings) fine aggregates, as specified.

Provide emery that is packaged, factory-graded, crushed natural emery ore containing not less than 35-percent aluminum oxide and not less than 24-percent ferric oxide. Provide aggregate that is cubical or polyhedral in form and does not change its physical or chemical nature in the presence of moisture. Grade aggregate to a fineness modulus of 3.9 to 4.0, with 100 percent passing 3/8-inch sieve and not less than 95 percent retained on No. 100 sieve. Deliver emery in moisture-resistant bags.

Provide traprock that is packaged, crushed, natural, fine- to medium-grained igneous rock such as diabase, basalt, or black granite. Uniformly grade coarse aggregate with 100 percent passing 1/2-inch sieve, 30 to 50 percent passing 3/8-inch sieve, 0 to 15 percent passing No. 4 sieve, and 0 to 5 percent passing No. 8 sieve.

Provide fine aggregate using traprock that conforms to ASTM C33/C33M, except gradation. Grade fine aggregate within the following limits:

SIEVE	PERCENT PASSING
3/8 in.	100
No. 4	95 to 100
No. 8	65 to 80
No. 16	45 to 65
No. 30	25 to 45
No. 50	5 to 15
No. 100	0 to 5

Deliver traprock coarse aggregate and fine aggregate in moisture-resistant bags.

2.4.4 Expansion/Contraction Joint Filler

ASTM D1751 Type I or Type II. Material must be 1/2 inch thick, unless otherwise indicated.

2.4.5 Joint Sealants

2.4.5.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D6690 or ASTM C920, Type S, Class 25, Use T.

2.4.5.2 Vertical Surfaces Greater Than 3 Percent Slope

ASTM C920, Type S, Grade NS, Class 25, Use T.

2.4.5.3 Preformed Polychloroprene Elastomeric Type

ASTM D2628.

2.4.5.4 Lubricant for Preformed Compression Seals

ASTM D2835.

2.4.6 Vapor Barrier

ASTM E1745 Class C polyethylene sheeting, minimum 10 mil thickness or other equivalent material with a maximum permeance rating of 0.04 perms per ASTM E96/E96M.

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.4.7 Dovetail Anchor Slot

Preformed metal slot approximately 1 inch by 1 inch of not less than 22 gage galvanized steel cast in concrete. Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material.

2.5 CONCRETE MIX DESIGN

2.5.1 Properties and Requirements

a. Use materials and material combinations listed in this section and the contract documents.

b. Cementitious material content must be adequate for concrete to satisfy the specified requirements for strength, w/cm, durability, and finishability described in this section and the contract documents.

The minimum cementitious material content for concrete used in floors must meet the following requirements:

Nominal maximum size of aggregate, in.	**Minimum cementitious material content, pounds per cubic yard**
1-1/2	470
1	520
3/4	540
3/8	610

c. Selected target slump must meet the requirements this section, the contract documents, and must not exceed 9 in. Concrete must not show visible signs of segregation.

d. The target slump must be enforced for the duration of the project. Determine the slump by ASTM C143/C143M. Slump tolerances must meet the requirements of ACI 117.

e. The nominal maximum size of coarse aggregate for a mixture must not

exceed three-fourths of the minimum clear spacing between reinforcement, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.

f. Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3. The total air content must be in accordance with the requirements of the paragraph titled DURABILITY.

g. Measure air content at the point of delivery in accordance with ASTM C173/C173M or ASTM C231/C231M.

h. Concrete for slabs to receive a hard-troweled finish must not contain an air-entraining admixture or have a total air content greater than 3 percent.

i. Concrete properties and requirements for each portion of the structure are specified in the table below. Refer to the paragraph titled DURABILITY for more details on exposure categories and their requirements.

	Minimum *f'c* psi	**Exposure Categories**	**Miscellaneous Requirements**
Footings	4500 at 28 days	S2; C1; W2; F2	Max. slump: 6 in. Nominal maximum aggregate size must be 3/4 in.
Columns and walls	4500 at 28 days	S2; C1; W2; F2	Nominal maximum aggregate size must be 3/4 in.
Beams and elevated slabs	4500 at 28 days	S2; C1; W2; F2	Nominal maximum aggregate size must be 3/4 in.

	Minimum *f'c* psi	Exposure Categories	Miscellaneous Requirements
Slabs-on-ground	4000 at 28 days	S1; C1; W1; F0	- Nominal maximum aggregate size must be 1.5 in - Maximum w/cm = 0.45 - No air entrapment required

2.5.2 Durability

2.5.2.1 Alkali-Aggregate Reaction

Do not use any aggregate susceptible to alkali-carbonate reaction (ACR). Use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction (ASR):

a. For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 must not exceed 0.04 percent at one year.

b. For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 must not exceed 0.10 percent at an age of 16 days.

c. Alkali content in concrete (LBA) must not exceed 4 pounds per cubic yard for moderately reactive aggregate or 3 pounds per cubic yard for highly reactive aggregate. Reactivity must be determined by testing in accordance with ASTM C1293 and categorized in accordance with ASTM C1778. Alkali content is calculated as follows:
LBA = (cement content, pounds per cubic yard) × (equivalent alkali content of portland cement in percent/100 percent)

2.5.2.2 Freezing and Thawing Resistance

a. Provide concrete meeting the following requirements based on exposure class assigned to members for freezing-and-thawing exposure in Contract Documents:

Exposure class	Maximum *w/cm**	Minimum *f'c*, psi	Air content	Additional Requirements
F0	N/A	2500	N/A	

Exposure class	Maximum *w/cm**	Minimum *f'c*, psi	Air content	Additional Requirements
F1	0.55	3500	Depends on aggregate size	N/A
F2	0.45	4500	Depends on aggregate size	See limits on maximum cementitious material by mass
F3	0.40	5000	Depends on aggregate size	See limits on maximum cementitious material by mass
F3 plain concrete	0.45	4500	Depends on aggregate size	See limits on maximum cementitious material by mass

*The maximum *w/cm* limits do not apply to lightweight concrete.

b. Concrete must be air entrained for members assigned to Exposure Class F1, F2, or F3. The total air content must meet the requirements of the following table:

Nominal maximum aggregate size, in.	Total air content, percent*^	
	Exposure Class F2 and F3	Exposure Class F1
3/8	7.5	6.0
1/2	7.0	5.5
3/4	6.0	5.0
1	6.0	4.5
1-1/2	5.5	4.5
2	5.0	4.0
3	5.5	3.5

*Tolerance on air content as delivered must be plus/minus 1.5 percent.

^For f'c greater than 5000 psi, reducing air content by 1.0 percentage point is acceptable.

c. Submit documentation verifying compliance with specified requirements.

d. For sections of the structure that are assigned Exposure Class F3, submit certification on cement composition verifying that concrete mixture meets the requirements of the following table:

Cementitious material	Maximum percent of total cementitious material by mass*
Fly ash or other pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM C989/C989M	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or other pozzolans, slag cement, and silica fume	50^
Total of fly ash or other pozzolans and silica fume	35^

*Total cementitious material also includes ASTM C150/C150M, ASTM C595/C595M, ASTM C845/C845M, and ASTM C1157/C1157M cement. The maximum percentages above must include:

i. Fly ash or other pozzolans present in ASTM C1157/C1157M or ASTM C595/C595M Type IP blended cement.

ii. Slag cement present in ASTM C1157/C1157M or ASTM C595/C595M Type IS blended cement.

iii. Silica fume conforming to ASTM C1240 present in ASTM C1157/C1157M or ASTM C595/C595M Type IP blended cement.

^Fly ash or other pozzolans and silica fume must constitute no more than 25 percent and 10 percent, respectively, of the total mass of the cementitious materials.

2.5.2.3 Corrosion and Chloride Content

a. Provide concrete meeting the requirements of the following table based on the exposure class assigned to members requiring protection against reinforcement corrosion in Contract Documents.

b. Submit documentation verifying compliance with specified requirements.

c. Water-soluble chloride ion content contributed from constituents including water, aggregates, cementitious materials, and admixtures must be determined for the concrete mixture by ASTM C1218/C1218M at age between 28 and 42 days.

d. The maximum water-soluble chloride ion (Cl-) content in concrete, percent by mass of cement is as follows:

Exposure class	Maximum *w/cm**	Minimum f'c, psi	Maximum water-soluble chloride ion (CL-) content in concrete, percent by mass of cement
Reinforced concrete			
C0	N/A	2500	1.00
C1	N/A	2500	0.30
C2	0.4	5000	0.15
Prestressed concrete			
C0	N/A	2500	0.06
C1	N/A	2500	0.06
C2	0.4	5000	0.06

*The maximum w/cm limits do not apply to lightweight concrete.

2.5.2.4 Sulfate Resistance

a. Provide concrete meeting the requirements of the following table based on the exposure class assigned to members for sulfate exposure.

Exposure class	Maximum w/cm	Minimum f'c, psi	Required cementitious materials-types			Calcium chloride admixture
			ASTM [illegible]	ASTM [illegible]	ASTM [illegible]	
S0	N/A	2500	N/A	N/A	N/A	No restrictions
S1	0.50	4000	II*^	Types with (MS) designation	MS	No restrictions
S2	0.45	4500	V^	Types with (HS) designation	HS	Not permitted
S3	0.45	4500	V + pozzolan or slag cement**	Types with (HS) designation plus pozzolan or slag cement**	HS + pozzolan or slag cement**	Not permitted
S3	0.40	5000	V***	Types with (HS) designation	HS	Not permitted

* For seawater exposure, other types of portland cements with tricalcium aluminate (C3A) contents up to 10 percent are acceptable if the w/cm does not exceed 0.40.

** The amount of the specific source of the pozzolan or slag cement to be used shall be at least the amount determined by test or service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slag used shall not be less than the amount tested in accordance with ASTM C1012/C1012M and meeting the requirements maximum

expansion requirements listed herein.

*** If Type V cement is used as the sole cementitious material, the optional sulfate requirement of 0.040 percent maximum expansion in ASTM C150/C150M shall be required.

^ Other available types of cement, such as Type III or Type I, are acceptable in exposure classes S1 or S2 if the C3A contents are less than 8 or 5 percent, respectively.

b. The maximum w/cm limits for sulfate exposure do not apply to lightweight concrete.

c. Alternative combinations of cementitious materials of those listed in this paragraph are acceptable if they meet the maximum expansion requirements listed in the following table:

Exposure class	**Maximum expansion when tested using ASTM C1012/C1012M**		
	At 6 months	**At 12 months**	**At 18 months**
S1	0.10 percent	N/A	N/A
S2	0.05 percent	0.10 percent^	N/A
S3	N/A	N/A	0.10 percent

^The 12-month expansion limit applies only when the measured expansion exceeds the 6-month maximum expansion limit.

2.5.2.5 Concrete Temperature

The temperature of concrete as delivered must not exceed 95°F .

2.5.2.6 Concrete permeability

a. Provide concrete meeting the requirements of the following table based on exposure class assigned to members requiring low permeability in the Contract Documents.

Exposure class	**Maximum *w/cm****	**Minimum f'c, psi**	**Additional minimum requirements**
W0	N/A	2500	None
W1	0.5	4000	None

*The maximum w/cm limits do not apply to lightweight concrete.

b. Submit documentation verifying compliance with specified requirements.

2.5.3 Contractor's Option for Material Only

At the option of the Contractor, those applicable material sections of

DOT RBS for Class A strength concrete must govern in lieu of this specification for concrete. Do not change the selected option during the course of the work.

2.5.4 Trial Mixtures

Trial mixtures must be in accordance to ACI 301.

2.5.5 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C94/C94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C94/C94M:

a. Type and brand cement

b. Cement and supplementary cementitious materials content in 94-pound bags per cubic yard of concrete

c. Maximum size of aggregate

d. Amount and brand name of admixtures

e. Total water content expressed by water cementitious material ratio

2.6 REINFORCEMENT

a. Bend reinforcement cold. Fabricate reinforcement in accordance with fabricating tolerances of ACI 117.

b. Submit manufacturer's certified test report for reinforcement.

c. Submit placing drawings showing fabrication dimensions and placement locations of reinforcement and reinforcement supports. Placing drawings must indicate locations of splices, lengths of lap splices, and details of mechanical and welded splices.

d. Submit request with locations and details of splices not indicated in Contract Documents.

e. Submit request to place column dowels without using templates.

f. Submit request and procedure to field-bend or straighten reinforcing bars partially embedded in concrete at locations not indicated in Contract Documents.

g. Submit request for field cutting, including location and type of bar to be cut and reason field cutting is required.

2.6.1 Reinforcing Bars

a. Reinforcing bars must be deformed, except spirals, load-transfer dowels, and welded wire reinforcement, which may be plain.

b. ASTM A615/A615M with the bars marked S, Grade 60; See Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING for cumulative total recycled content requirements.

c. Reinforcing bars may contain post-consumer or post-industrial recycled content.

d. Submit mill certificates for reinforcing bars.

2.6.1.1 Headed Reinforcing Bars

Headed reinforcing bars must conform to ASTM A970/A970M including Annex A1, and other specified requirements.

2.6.1.2 Bar Mats

a. Bar mats must conform to ASTM A184/A184M.

b. If coated bar mats are required, repair damaged coating as required in the paragraph titled GALVANIZED REINFORCING BARS EPOXY-COATED REINFORCING BARS and DUAL-COATED REINFORCING BARS.

2.6.1.3 Headed Shear Stud Reinforcement

Headed studs and headed stud assemblies must conform to ASTM A1044/A1044M.

2.6.2 Mechanical Reinforcing Bar Connectors

a. Provide 125 percent minimum yield strength of the reinforcement bar.

b. Mechanical splices for galvanized reinforcing bars must be galvanized or coated with dielectric material.

c. Mechanical splices used with epoxy-coated or dual-coated reinforcing bars must be coated with dielectric material.

d. Submit data on mechanical splices demonstrating compliance with this paragraph.

2.6.3 Wire

a. Provide wire reinforcement that contains a minimum of 100 percent recycled content.Provide flat sheets of welded wire reinforcement for slabs and toppings.

b. Plain or deformed steel wire must conform to ASTM A1064/A1064M.

c. Stainless steel wire must conform to ASTM A1022/A1022M.

d. Epoxy-coated wire must conform to ASTM A884/A884M. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated wires must be repaired. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire, wire must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A884/A884M. Fading of coating color shall not be cause for rejection of epoxy-coated wire reinforcement.

2.6.4 Welded wire reinforcement

a. Use welded wire reinforcement specified in Contract Documents and conforming to one or more of the specifications given herein.

b. Plain welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 12 in. apart in direction of principal reinforcement.

c. Deformed welded wire reinforcement must conform to ASTM A1064/A1064M, with welded intersections spaced no greater than 16 in. apart in direction of principal reinforcement.

d. Epoxy-coated welded wire reinforcement must conform to ASTM A884/A884M. Coating damage incurred during shipment, storage, handling, and placing of epoxy-coated welded wire reinforcement must be repaired in accordance with ASTM A884/A884M. Repair damaged coating areas with patching material in accordance with material manufacturer's written recommendations. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area must include repaired areas damaged before shipment as required by ASTM A884/A884M. Fading of coating color shall not be cause for rejection of epoxy-coated welded wire reinforcement.

e. Stainless steel welded wire reinforcement must conform to ASTM A1022/A1022M.

f. Zinc-coated (galvanized) welded wire reinforcement must conform to ASTM A1060/A1060M. Coating damage incurred during shipment, storage, handling, and placing of zinc-coated (galvanized) welded wire reinforcement must be repaired in accordance with ASTM A780/A780M. If damaged area exceeds 2 percent of surface area in each linear foot of each wire or welded wire reinforcement, the sheet containing the damaged area must not be used. The 2 percent limit on damaged coating area shall include repaired areas damaged before shipment as required by ASTM A1060/A1060M.

2.6.5 Reinforcing Bar Supports

a. Provide reinforcement support types within structure as required by Contract Documents. Reinforcement supports must conform to CRSI RB4.1. Submit description of reinforcement supports and materials for fastening coated reinforcement if not in conformance with CRSI RB4.1.

b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar support. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer coated wire bar supports.

c. Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

d. Minimum 5 percent post-consumer recycled content, or minimum 20 percent post-industrial recycled content.

2.6.6 Dowels for Load Transfer in Floors

Provide greased dowels for load transfer in floors of the type, design, weight, and dimensions indicated. Provide dowel bars that are plain-billet steel conforming to ASTM A615/A615M, Grade 40. Provide dowel pipe that is steel conforming to ASTM A53/A53M.

2.6.7 Welding

a. Provide weldable reinforcing bars that conform to ASTM A706/A706M and ASTM A615/A615M and Supplement S1, Grade 60, except that the maximum carbon content must be 0.55 percent.

b. Comply with AWS D1.4/D1.4M unless otherwise specified. Do not tack weld reinforcing bars.

c. Welded assemblies of steel reinforcement produced under factory conditions, such as welded wire reinforcement, bar mats, and deformed bar anchors, are allowed.

d. After completing welds on zinc-coated (galvanized), epoxy-coated, or zinc and epoxy dual-coated reinforcement, coat welds and repair coating damage as previously specified.

PART 3 EXECUTION

3.1 EXAMINATION

a. Do not begin installation until substrates have been properly constructed; verify that substrates are level.

b. If substrate preparation is the responsibility of another installer, notify Contracting Officer of unsatisfactory preparation before processing.

c. Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Contracting Officer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

a. Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

b. Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

a. When subgrade material is semi-porous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time

concrete is deposited, or seal subgrade surface by covering surface with specified vapor retarder.

b. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder.

3.2.3 Subgrade Under Slabs on Ground

a. Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

b. Previously constructed subgrade or fill must be cleaned of foreign materials

c. Finish surface of capillary water barrier under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

d. Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

3.2.4 Edge Forms and Screed Strips for Slabs

a. Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment.

b. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.5 Reinforcement and Other Embedded Items

a. Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

b. When concrete is placed, reinforcement must be free of materials deleterious to bond. Reinforcement with rust, mill scale, or a combination of both will be considered satisfactory, provided minimum nominal dimensions, nominal weight, and minimum average height of deformations of a hand-wire-brushed test specimen are not less than applicable ASTM specification requirements.

3.3 FORMS

a. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade.

b. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch. Place chamfer strips in corners of formwork to produce beveled edges on permanently exposed surfaces.

c. Provide formwork with clean-out openings to permit inspection and removal of debris.

d. Inspect formwork and remove foreign material before concrete is placed.

e. At construction joints, lap form-facing materials over the concrete of previous placement. Ensure formwork is placed against hardened concrete so offsets at construction joints conform to specified tolerances.

f. Provide positive means of adjustment (such as wedges or jacks) of shores and struts. Do not make adjustments in formwork after concrete has reached initial setting. Brace formwork to resist lateral deflection and lateral instability.

g. Fasten form wedges in place after final adjustment of forms and before concrete placement.

h. Provide anchoring and bracing to control upward and lateral movement of formwork system.

i. Construct formwork for openings to facilitate removal and to produce opening dimensions as specified and within tolerances.

j. Provide runways for moving equipment. Support runways directly on formwork or structural members. Do not support runways on reinforcement. Loading applied by runways must not exceed capacity of formwork or structural members.

k. Position and support expansion joint materials, waterstops, and other embedded items to prevent displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with removable material to prevent concrete entry into voids.

l. Clean surfaces of formwork and embedded materials of mortar, grout, and foreign materials before concrete placement.

3.3.1 Coating

a. Cover formwork surfaces with an acceptable material that inhibits bond with concrete.

b. If formwork release agent is used, apply to formwork surfaces in accordance with manufacturer's recommendations before placing reinforcement. Remove excess release agent on formwork prior to concrete placement.

c. Do not allow formwork release agent to contact reinforcement or hardened concrete against which fresh concrete is to be placed.

3.3.2 Reshoring

a. Do not allow structural members to be loaded with combined dead and construction loads in excess of loads indicated in the accepted procedure.

b. Install and remove reshores or backshores in accordance with accepted procedure.

c. For floors supporting shores under newly placed concrete, either leave original supporting shores in place, or install reshores or backshores. Shoring system and supporting slabs must resist anticipated loads. Locate reshores and backshores directly under a

shore position or as indicated on formwork shop drawings.

d. In multistory buildings, place reshoring or backshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads.

3.3.3 Reuse

a. Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

b. Wood forms must not be clogged with paste and must be capable of absorbing high water-cementitious material ratio paste.

c. Remove leaked mortar from formwork joints before reuse.

3.3.4 Forms for Standard Rough Form Finish

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-1.0, for formed surfaces that are to be concealed by other construction.

3.3.5 Forms for Standard Smooth Form Finish

Provide formwork in accordance with ACI 301 Section 5 with a surface finish, SF-3.0, for formed surfaces that are exposed to view.

3.3.6 Form Ties

a. For post-tensioned structures, do not remove formwork supports until stressing records have been accepted by the Contracting Officer.

b. After ends or end fasteners of form ties have been removed, repair tie holes in accordance with ACI 301 Section 5 requirements.

3.3.7 Forms for Concrete Pan Joist Construction

Pan-form units for one-way or two-way concrete joist and slab construction must be factory-fabricated units of the approximate section indicated. Units must consist of steel or molded fiberglass concrete form pans. Closure units must be furnished as required.

3.3.8 Tolerances for Form Construction

a. Construct formwork so concrete surfaces conform to tolerances in ACI 117.

b. Position and secure sleeves, inserts, anchors, and other embedded items such that embedded items are positioned within ACI 117 tolerances.

c. To maintain specified elevation and thickness within tolerances, install formwork to compensate for deflection and anticipated settlement in formwork during concrete placement. Set formwork and intermediate screed strips for slabs to produce designated elevation, camber, and contour of finished surface before formwork removal. If specified finish requires use of vibrating screeds or roller pipe screeds, ensure that edge forms and screed strips are strong enough to support such equipment.

3.3.9 Removal of Forms and Supports

a. If vertical formed surfaces require finishing, remove forms as soon as removal operations will not damage concrete.

b. Remove top forms on sloping surfaces of concrete as soon as removal will not allow concrete to sag. Perform repairs and finishing operations required. If forms are removed before end of specified curing period, provide curing and protection.

c. Do not damage concrete during removal of vertical formwork for columns, walls, and sides of beams. Perform needed repair and finishing operations required on vertical surfaces. If forms are removed before end of specified curing period, provide curing and protection.

d. Leave formwork and shoring in place to support construction loads and weight of concrete in beams, slabs, and other structural members until in-place required strength of concrete is reached.

e. Form-facing material and horizontal facing support members may be removed before in-place concrete reaches specified compressive strength if shores and other supports are designed to allow facing removal without deflection of supported slab or member.

3.3.10 Strength of Concrete Required for Removal of Formwork

If removal of formwork, reshoring, or backshoring is based on concrete reaching a specified in-place strength, mold and field-cure cylinders in accordance with ASTM C31/C31M. Test cylinders in accordance with ASTM C39/C39M. Alternatively, use one or more of the methods listed herein to evaluate in-place concrete strength for formwork removal.

a. Tests of cast-in-place cylinders in accordance with ASTM C873/C873M. This option is limited to slabs with concrete depths from 5 to 12 in.

b. Penetration resistance in accordance with ASTM C803/C803M.

c. Pullout strength in accordance with ASTM C900.

d. Maturity method in accordance with ASTM C1074. Submit maturity method data using project materials and concrete mix proportions used on the project to demonstrate the correlation between maturity and compressive strength of laboratory cured test specimens to the Contracting Officer.

3.4 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

a. Unless otherwise specified, placing reinforcement and miscellaneous materials must be in accordance to ACI 301. Provide bars, welded wire reinforcement, wire ties, supports, and other devices necessary to install and secure reinforcement.

b. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

c. Nonprestressed cast-in-place concrete members must have concrete cover for reinforcement given in the following table:

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	All	No. 6 through No. 18 bars	2
		No. 5 bar, W31 or D31 wire, and smaller	1-1/2
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 14 and No. 18 bars	1-1/2
		No. 11 bar and smaller	3/4
	Beams, columns, pedestals, and tension ties	Primary reinforcement, stirrups, ties, spirals, and hoops	1-1/2

d. Cast-in-place prestressed concrete members must have concrete cover for reinforcement, ducts, and end fittings given in the following table:

Concrete	Member	Reinforcement	Specified
Cast against and permanently in contact with ground	All	All	3
Exposed to weather or in contact with ground	Slabs, joists, and walls	All	1
	All other	All	1-1/2

Concrete	Member	Reinforcement	Specified
Not exposed to weather or in contact with ground	Slabs, joists, and walls	All	3/4
	Beams, columns, and tension ties	Primary reinforcement	1-1/2
		Stirrups, ties, spirals, and hoops	1

e. Precast nonprestressed or prestressed concrete members manufactured under plant conditions must have concrete cover for reinforcement, ducts, and end fittings given in the following table:

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Exposed to weather or in contact with ground	Walls	No. 14 and No. 18 bars; tendons larger than 1-1/2 in. diameter	1-1/2
		No. 11 bars and smaller; W31 and D31 wire, and smaller; tendons and strands 1-1/2 in.	3/4
	All other	No. 14 and No. 18 bars; tendons larger than 1-1/2 in.	2
		No. 6 through No. 11 bars; tendons and strands larger than 5/8 in. diameter through 1-1/2 in.	1-1/2
		No. 5 bar, W31 or D31 wire, and smaller; tendons and strands 5/8 in. diameter and smaller	1-1/4

Concrete Exposure	Member	Reinforcement	Specified cover, in.
Not exposed to weather or in contact with ground	Slabs, joists, and walls	No. 14 and No. 18 bars; tendons larger than 1-1/2 in. diameter	1-1/4
		Tendons and strands 1-1/2 in. diameter and smaller	3/4
		No. 11 bar, W31 or D31	5/8
	Beams, columns, pedestals, and tension ties	Primary reinforcement	Greater of bar diameter and 5/8 and need not exceed 1-1/2
		Stirrups, ties, spirals, and hoops	3/8

3.4.1 General

Provide details of reinforcement that are in accordance with the Contract Documents.

3.4.2 Vapor Retarder

a. Install in accordance with ASTM E1643. Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches and tape.

b. Remove torn, punctured, or damaged vapor retarder material and provide with new vapor retarder prior to placing concrete. Concrete placement must not damage vapor retarder. Place vapor barrier directly on underlying subgrade, base course, or capillary water barrier, unless it consists of crushed material or large granular material which could puncture the vapor barrier. In this case, a thin layer of approximately 1/2 inch of fine graded material should be rolled or compacted over the fill before installation of the vapor barrier to reduce the possibility of puncture. Control concrete placement so as to prevent damage to the vapor barrier.

3.4.3 Perimeter Insulation

Install perimeter insulation at locations indicated. Adhesive must be

used where insulation is applied to the interior surface of foundation walls and may be used for exterior application.

3.4.4 Reinforcement Supports

Provide reinforcement support in accordance with CRSI RB4.1 and ACI 301 Section 3 requirements. Supports for coated or galvanized bars must also be coated with electrically compatible material for a distance of at least 2 inches beyond the point of contact with the bars.

3.4.5 Splicing

As indicated in the Contract Documents. For splices not indicated follow ACI 301. Do not splice at points of maximum stress. Overlap welded wire reinforcement the spacing of the cross wires, plus 2 inches. AWS D1.4/D1.4M. Approve welded splices prior to use.

3.4.6 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Caulk the depression after the bolt is installed.

3.4.7 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement and support against displacement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.4.8 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

a. Provide fabrication tolerances that are in accordance with ACI 117.

b. Provide hooks and bends that are in accordance with the Contract Documents.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances

b. Bends or kinks not indicated on drawings or approved shop drawings

c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.4.9 Placing Reinforcement

Place reinforcement in accordance with ACI 301.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire reinforcement on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than 1 inch from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

a. Provide supports for reinforcing bars that are sufficient in number and have sufficient strength to carry the reinforcement they support, and in accordance with ACI 301 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

b. Equip supports on ground and similar surfaces with sand-plates.

c. Support welded wire reinforcement as required for reinforcing bars.

d. Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

e. Reinforcement must be accurately placed, securely tied at intersections, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to the Contract Documents.

f. Bending of reinforcing bars partially embedded in concrete is permitted only as specified in the Contract Documents.

3.4.10 Spacing of Reinforcing Bars

a. Spacing must be as indicated in the Contract Documents.

b. Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to preapproval by the Contracting Officer.

3.4.11 Concrete Protection for Reinforcement

Additional concrete protection must be in accordance with the Contract Documents.

3.4.12 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

3.5 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

In accordance with ASTM C94/C94M, ACI 301, ACI 302.1R and ACI 304R, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.5.1 Measuring

Make measurements at intervals as specified in paragraphs SAMPLING and TESTING.

3.5.2 Mixing

a. Mix concrete in accordance with ASTM C94/C94M, ACI 301 and ACI 304R.

b. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates. If discharge is acceptable after more than 90 minutes the air content, slump, and concrete temperature shall be tested and shall be within the specified limits. A retarder shall be used to facilitate placing and finishing when concrete temperature is 85 degrees F or greater.

c. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture, within the manufacturer's recommended dosage, to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch. Do not reconstitute concrete that has begun to solidify.

d. When fibers are used, add fibers together with the aggregates and never as the first component in the mixer. Fibers must be dispensed into the mixing system using appropriate dispensing equipment and procedure as recommended by the manufacturer.

3.5.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.6 PLACING CONCRETE

Place concrete in accordance with ACI 301 Section 5. Concrete shall be placed within 15 minutes of discharge into non-agitating equipment.

3.6.1 Pumping

ACI 304R and ACI 304.2R. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches at discharge/placement. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well-rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.6.2 Cold Weather

Cold weather concrete must meet the requirements of ACI 301 unless otherwise specified. Do not allow concrete temperature to decrease below 50 degrees F. Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any one hour and 50 degrees F per 24 hours after heat application.

3.6.3 Hot Weather

Hot weather concrete must meet the requirements of ACI 301 unless otherwise specified. Maintain required concrete temperature using Figure 4.2 in ACI 305R to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.6.4 Bonding

Surfaces of set concrete at joints, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

a. At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.

b. At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.

c. Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

3.7 WASTE MANAGEMENT

Provide as specified in the Waste Management Plan and as follows.

3.7.1 Mixing Equipment

Before concrete pours, designate Contractor-owned site meeting environmental standards or on-site area to be paved later in project for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.7.2 Hardened, Cured Waste Concrete

Crush and reuse hardened, cured waste concrete as fill or as a base course for pavement.

3.7.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.7.4 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material. Return excess cement to supplier.

3.8 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.8.1 Defects

Repair surface defects in accordance with ACI 301 Section 5.

3.8.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

3.8.3 Formed Surfaces

3.8.3.1 Tolerances

Tolerances in accordance with ACI 117 and as indicated.

3.8.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view a surface finish SF-1.0. Patch holes and defects in accordance with ACI 301.

3.8.3.3 Standard Smooth Finish

Provide for surfaces exposed to public view a surface finish SF-3.0. Patch holes and defects in accordance with ACI 301.

3.9 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

In accordance with ACI 301 and ACI 302.1R, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Where straightedge measurements are specified, Contractor must provide straightedge.

3.9.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater. Grate tampers ("jitterbugs") shall not be used.

3.9.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. Finish concrete in accordance with ACI 301 Section 5 for a scratched finish.

3.9.1.2 Floated

Use for surfaces to receive roofing, and exterior slabs where not otherwise specified. Finish concrete in accordance with ACI 301 Section 5 for a floated finish.

3.9.1.3 Steel Troweled

Use for floors intended as walking surfaces and for reception of floor coverings. Finish concrete in accordance with ACI 301 Section 5 for a steel troweled finish.

3.9.1.4 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Finish concrete in accordance with ACI 301 Section 5 for a broomed finish.

3.9.1.5 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by belting. Lay belt flat on the concrete surface and advance with a sawing motion; continue until a uniform but gritty nonslip surface is obtained. Round edges and joints with an edger having a radius of 1/8 inch.

3.9.1.6 Concrete Toppings Placement

The following requirements apply to the placement of toppings of concrete on base slabs that are either freshly placed and still plastic, or on hardened base slabs.

a. Placing on a Fresh Base: Screed and bull float the base slab. As soon as the water sheen has disappeared, lightly rake the surface of the base slab with a stiff bristle broom to produce a bonding surface for the topping. Immediately spread the topping mixture evenly over the roughened base before final set takes place. Give the topping the finish specified herein.

b. Bonding to a Hardened Base: When the topping is to be bonded to a floated or troweled hardened base, roughen the base by scarifying, grit-blasting, scabbling, planing, flame cleaning, or acid-etching to lightly expose aggregate and provide a bonding surface. Remove dirt, laitance, and loose aggregate by means of a stiff wire broom. Keep the clean base wet for a period of 12 hours preceding the application of the topping. Remove excess water and apply a 1:1:1/2 cement-sand-water grout, and brush into the surface of the base slab. Do not allow the cement grout to dry, and spread it only short distances ahead of the topping placement. Do not allow the temperature differential between the completed base and the topping mixture to exceed 41 degrees F at the time of placing. Place the topping and finish as specified herein.

3.9.2 Concrete Walks

Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints 1 inch deep, or one fourth the slab thickness whichever is deeper, with a jointing tool after the surface has been finished. Provide 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 1/4 inch in 5 feet.

3.9.3 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.9.4 Curbs and Gutters

Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Perform pavement finish.

3.9.5 Splash Blocks

Provide at outlets of downspouts emptying at grade. Splash blocks may be precast concrete, and must be 24 inches long, 12 inches wide and 4 inches thick, unless otherwise indicated, with smooth-finished countersunk dishes sloped to drain away from the building.

3.10 JOINTS

3.10.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Joints must be perpendicular to main reinforcement. Reinforcement must be continued and developed across construction joints. Locate construction joints as follows:

3.10.1.1 Construction Joints for Constructability Purposes

a. In walls, at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall.

b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier.

c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.

Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

3.10.2 Isolation Joints in Slabs on Ground

a. Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

b. Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

3.10.3 Contraction Joints in Slabs on Ground

a. Provide joints to form panels as indicated.

b. Under and on exact line of each control joint, cut 50 percent of welded wire reinforcement before placing concrete.

c. Sawcut contraction joints into slab on ground in accordance with ACI 301 Section 5.

d. Joints must be 1/8-inch wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean

groove of foreign matter and loose particles.

3.10.4 Sealing Joints in Slabs on Ground

a. Contraction and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

b. Sealed groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.11 CURING AND PROTECTION

Curing and protection in accordance with ACI 301 Section 5, unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer, hardener, or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.11.1 Requirements for Type III, High-Early-Strength Portland Cement

The curing periods are required to be not less than one-fourth of those specified for portland cement, but in no case less than 72 hours.

3.11.2 Curing Periods

ACI 301 Section 5, except 10 days for retaining walls, pavement or chimneys. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.11.3 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.11.4 Curing Unformed Surfaces

a. Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.

b. Accomplish final curing of unformed surfaces by any of curing methods specified, as applicable.

c. Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.11.5 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any one hour nor 80 degrees F in any 24-hour period.

3.11.6 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.11.7 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.12 FIELD QUALITY CONTROL

3.12.1 Aggregate Testing

3.12.1.1 Fine Aggregate

At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall be immediately reported to the Contracting Officer, concreting shall be stopped, and immediate steps taken to correct the grading.

3.12.1.2 Coarse Aggregate

At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of 5 tests are outside specification limits, the operation shall be considered out of control and reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

3.12.2 Concrete Sampling

ASTM C172/C172M. Collect samples of fresh concrete to perform tests specified. ASTM C31/C31M for making test specimens.

3.12.3 Concrete Testing

3.12.3.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement/discharge. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cementitious material ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made.

3.12.3.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.12.3.3 Compressive Strength Tests

ASTM C39/C39M. Make six 6 inch by 12 inch or nine 4 inch by 8 inch test cylinders for each set of tests in accordance with ASTM C31/C31M, ASTM C172/C172M and applicable requirements of ACI 305R and ACI 306R. Take precautions to prevent evaporation and loss of water from the specimen. Test two 6 inch by 12 inch or three 4 inch by 8 inch cylinders at 7 days, two 6 inch by 12 inch or three 4 inch by 8 inch cylinders at 28 days, and hold two 6 inch by 12 inch or three 4 inch by 8 inch cylinders in reserve. Take samples for strength tests for each concrete mixture placed each day not less than once a day, nor less than once for each 150 cubic yards of concrete, nor less than once for each 5000 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design

of concrete placed. Each strength test result must be the average of two 6 inch by 12 inch or three 4 inch by 8 inch cylinders from the same concrete sample tested at 28 days . Concrete compressive tests must meet the requirements of this section, the Contract Document, and ACI 301.

3.12.3.4 Strength of Concrete Structure

The strength of the concrete structure will be considered to be deficient if any of the following conditions are identified:

a. Failure to meet compressive strength tests as evaluated.

b. Reinforcement not conforming to requirements specified.

c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.

d. Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified.

e. Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.

f. Poor workmanship likely to result in deficient strength.

Where the strength of the concrete structure is considered deficient submit a mitigation or remediation plan for review and approval by the contracting officer.

3.12.3.5 Non-Conforming Materials

Factors that indicate that there are non-conforming materials include (but not limited to) excessive compressive strength, inadequate compressive strength, excessive slump, excessive voids and honeycombing, concrete delivery records that indicate excessive time between mixing and placement, or excessive water was added to the mixture during delivery and placement. Any of these indicators alone are sufficient reason for the Contracting Officer to request additional sampling and testing.

Investigations into non-conforming materials must be conducted at the Contractor's expense. The Contractor must be responsible for the investigation and must make written recommendations to adequately mitigate or remediate the non-conforming material. The Contracting Officer may accept, accept with reduced payment, require mitigation, or require removal and replacement of non-conforming material at no additional cost to the Government.

3.12.3.6 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements or there are non-conforming materials, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C42/C42M, and as follows:

a. Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

b. Test cores after moisture conditioning in accordance with ASTM C42/C42M

if concrete they represent is more than superficially wet under service.

c. Air dry cores, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

d. Strength of cores from each member or area are considered satisfactory if their average compressive strength is equal to or greater than 85 percent of the design compressive strength, and if no single core strength is less than 75 percent of the design compressive strength. Additional testing of cores extracted from locations represented by erratic core strength results will be permitted only when approved by the Contracting Officer.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.13 REPAIR, REHABILITATION AND REMOVAL

Before the Contracting Officer accepts the structure the Contractor must inspect the structure for cracks, damage and substandard concrete placements that may adversely affect the service life of the structure. A report documenting these defects must be prepared which includes recommendations for repair, removal or remediation must be submitted to the Contracting Officer for approval before any corrective work is accomplished.

3.13.1 Crack Repair

Prior to final acceptance, all cracks in excess of 0.02 inches wide must be documented and repaired. The proposed method and materials to repair the cracks must be submitted to the Contracting Officer for approval. The proposal must address the amount of movement expected in the crack due to temperature changes and loading.

3.13.2 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. Concrete surfaces with weak surfaces less than 1/4 inch thick must be diamond ground to remove the weak surface. Surfaces containing weak surfaces greater than 1/4 inch thick must be removed and replaced or mitigated in a manner acceptable to the Contracting Officer.

3.13.3 Failure of Quality Assurance Test Results

Proposed mitigation efforts by the Contractor must be approved by the Contracting Officer prior to proceeding.

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 251	(2006; R 2011) Standard Specification for Plain and Laminated Elastomeric Bridge Bearings

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.2	(1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 301	(2020) Specifications for Structural Concrete
ACI 304R	(2000; R 2009) Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(1995; R 2004) Basic Hardboard

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum

	Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A416/A416M	(2024) Standard Specification for Low-Relaxation, Seven-Wire for Prestressed Concrete
ASTM A449	(2014; R 2020) Standard Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by

	the Hot-Dip Process
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A1064/A1064M	(2022) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024b) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2023) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2022) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C311/C311M	(2024) Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for

	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C979/C979M	(2016) Standard Specification for Pigments for Integrally Colored Concrete
ASTM C989/C989M	(2022) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1157/C1157M	(2023) Standard Performance Specification for Hydraulic Cement
ASTM C1218/C1218M	(2020c) Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D746	(2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1149	(2018) Standard Test Method for Rubber Deterioration - Cracking in an Ozone Controlled Environment
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D5759	(2012; R 2020) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses

PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI MNL-117	(2013) Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products, 3rd Edition
PCI MNL-122	(2007) Architectural Precast Concrete, 3rd Edition

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" classification are for

information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Pre-Installation Meeting

SD-02 Shop Drawings

Precast Drawings; G, DO

SD-03 Product Data

Cast-In Embedded Items And Connectors; G, DO

Connection Devices; G, DO

Admixtures

Gasket; G, RO

Bearing Pads

SD-04 Samples

Concrete Wall Panel Surface Finish; G, RO

SD-05 Design Data

Design Calculations; G,DO

Contractor-Furnished Mix Design

Concrete Mix Design for Repair of Surface Defects;

Thermal Calculations;

SD-06 Test Reports

Strength Tests; G, DO

Slump

Air Content

Test for Concrete Materials

Water

Testing Precast Units for Strength

SD-07 Certificates

Manufacturer's Qualifications; G, RO

Fabricator Quality Certifications

Erector Certification

Erector's Post Audit Declaration

SD-08 Manufacturer's Instructions

Installation; G, RO

Cleaning;

SD-11 Closeout Submittals

Concrete Batch Ticket Information

Recycled Content for Fly Ash and Pozzolan

Recycled Content for Ground Iron Blast-Furnace Slag

Recycled Content for Silica Fume

1.3 MODIFICATION OF REFERENCES

In the referenced ACI and PCI publications, consider the advisory provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.4 GENERAL REQUIREMENTS

Precast concrete units must be designed and fabricated by an experienced and certified precast concrete manufacturer. The manufacturer needs to have been regularly and continuously engaged in the manufacture of precast concrete work similar to that indicated on the drawings for at least 3 years. The Contractor must submit a statement detailing the Manufacturer's Qualifications. Coordinate precast work with the work of other trades.

1.5 DESIGN

1.5.1 Standards and Loads

Precast unit design must conform to ASCE 7-16, ACI 318 and PCI MNL-122. Indicate design loads for precast concrete on the drawings. A differential temperature of 100 degrees F, between interior and exterior faces of the units, must be considered in the design. Stresses due to restrained volume change caused by shrinkage and temperature differential, handling, transportation and erection must be accounted for in the design.

1.5.2 Connections

Connection of units to other members, or to other units must be of the type and configuration indicated. The design and sizing of connections for all design loads will be completed by the Contractor.

1.5.3 Concrete Proportion

Base the selection of proportions for concrete on the methodology presented in ACI 211.1 for normal weight concrete and ACI 211.2 for lightweight concrete. Develop the concrete proportion using the same type

and brand of cement, the same type and gradation of aggregates, and the same type and brand of admixture that will be used in the manufacture of precast concrete units for the project. Do not use calcium chloride in precast concrete and admixtures containing chloride ions, nitrates, or other substances that are corrosive will not be used in prestressed concrete.

1.5.4 Design Calculations

Calculations for design of members, connections and embedments not shown must be made by a registered professional engineer experienced in the design of precast architectural concrete. Calculation will include the analysis of member for lifting stresses and the sizing of the lifting inserts. Submit calculations for review and approval prior to fabrication, signed and sealed by the registered design professional who prepared the design.

1.5.5 Thermal Calculations

Submit thermal calculations prepared and sealed by a registered professional engineer for review complying with ASHRAE 90.1 - IP, for the steady state thermal resistance for the precast concrete wall panels. Thermal calculations must demonstrate the thermal conductivity of all components, the spacing of all connectors, the percent area of the wall that is solid concrete, and the thermal resistance of all components.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver packaged materials, except for wall panels, to the project site in the original, unbroken packages or containers, each bearing a label clearly identifying manufacturer's name, brand name, weight or volume, and other pertinent information. Store packaged materials, and materials in containers, in a weathertight and dry place until ready for use.

Store products in manufacturer's unopened packaging in dry storage area, with ambient temperature between 30 degrees F and 120 degrees F, until installation.

1.7 STORAGE AND INSPECTION AT MANUFACTURER'S PLANT

Protect precast units temporarily stored at the manufacturer's plant from damage in accordance with PCI MNL-117 and PCI MNL-122. Immediately prior to shipment to the jobsite, all precast concrete units must be inspected for quality to insure all precast units conform to the requirements specified. Inspection for quality will include, but will not be limited to, the following elements: color, texture, dimensional tolerances, chipping, cracking, staining, warping and honeycombing. Replace or repair all defective precast concrete units as approved.

1.8 PLANT INSPECTION

At the option of the Contracting Officer, precast units may be inspected. The Contractor is to give notice 14 days prior to the time the units will be available for plant inspection. Neither the exercise nor waiver of inspection at the plant will affect the Government's right to enforce contractual provisions after units are transported or erected.

1.8.1 Fabricator Quality Certifications

Plants must be certified by the PCI Plant Certification Program for Group A, Category A1, or Architectural Precast Association (APA) certification or National Precast Concrete Association (NPCA). When plants are not currently enrolled in one of the three certification programs listed above then they must provide a product quality control system in accordance with PCI MNL-117 and perform concrete and aggregate quality control testing using an approved, independent commercial testing laboratory.

1.9 ERECTOR CERTIFICATION

Erector with erecting organization and all erecting crews certified and designated by PCI's Certificate of Compliance to erect Category S2 (Complex Structural Systems) for load-bearing members.

1.10 ERECTOR QUALIFICATIONS

A precast erector that is not certified by PCI who retains a PCI-Certified Field Auditor, at the erector's expense, to conduct a field audit of a project in the same category as this project prior to start of precast concrete erection and must submit the Erector's Post Audit Declaration to be considered qualified.

1.11 CONCRETE SAMPLING AND TESTING

1.11.1 Test for Concrete Materials

Sample and test concrete materials proposed for use in the work in accordance with PCI MNL-117.

Submit reports for each material sampled and tested prior to the start of work. Reports must contain the project name and number, date, name of Contractor, name of precast unit manufacturer, name of concrete testing service, source of concrete aggregates, generic name of aggregate, and values specified.

1.11.2 Quality Control Testing During Fabrication

Sample and test concrete for quality control during fabrication as follows:

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Sampling fresh concrete	ASTM C172/C172M except modified for slump per ASTM C94/C94M	As required for each test
Slump test	ASTM C143/C143M	One for each concrete load at point of discharge and one for each set of compressive strength tests

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Air Content by pressure method	ASTM C231/C231M	One for each set of compressive strength tests
Compressive test specimens	ASTM C31/C31M	One set of six specimens for each Compressive Strength test, one set per day or for every 100 cubic yards of concrete placed, whichever is greater.

Compression test specimens may be either standard 6 by 12 inch cylinders or 4-inch cubes. Cubes may be molded individually or cut from slabs. Preparation and testing of cube specimens must be as nearly consistent with the test methods specified as possible, with the exception that the concrete will be placed in a single layer.

Curing of compression test specimens must be the same as the curing method used for the precast concrete wall panels until panels are stripped of forms and then standard moist cure will continue.

REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Concrete temperature		Each time a set of compression test specimens is made
Compressive strength tests	ASTM C39/C39M	One set of facing strength tests mix and one set of backing mix for every ten panels or fraction thereof cast in any one day; two specimens in each set tested at 7 calendar days; three specimens in each set tested at 28 calendar days, and one specimen in each set retained in reserve for testing if required

Evaluate compression test results at 28 days in accordance with ACI 214R using a coefficient of variation of 20 percent. Evaluate the strength of concrete by averaging the test results (two specimens) of standard cylinders tested at 28 days. Not more than 20 percent of the individual tests can have an average compressive strength less than the specified ultimate compressive strength. Submit test reports on the same day that tests are made.

Reports for Compressive Strength tests need to contain the project name and number, date of concrete placement, name of Contractor, name of precast concrete wall panel manufacturer, name of concrete testing service, panel identification letter and number, use of concrete mixture (facing or backing), design compressive strength at 28 calendar days, concrete-mix proportions and materials, and compressive breaking strength and type of break.

If 4-inch cubes are used for compressive strength specimens, average strength of the cubes at any test age must be multiplied by the factor of 0.8 to arrive at an estimate of the corresponding 6 by 12 inch cylinder strength. Report both of these values .

1.12 QUALITY ASSURANCE

1.12.1 Precast Drawings

Submit precast drawings with the following information:

a. Precast dimensions, cross-section, and edge details; location, size, and type of reinforcement, including reinforcement necessary for safe handling and erection of precast units and other embedded items. Comply with ACI SP-66.

b. Layout, dimensions, and identification of each precast unit, corresponding to installation sequence.

c. Setting drawings, instructions, and directions for installation of concrete inserts.

d. Location and details of anchorage devices and lifting devices embedded in panels, and connection details to building framing system.

e. Location of embedded brick work including joint locations, joint widths, brick coursing, brick coursing alignment across panel joints and reveal and false-joint locations and dimensions.

1.12.2 Concrete Wall Panel Surface Finish Sample

Submit a concrete wall panel sample 12 inches by 12 inches by approximately 1 1/2 inches in thickness, to illustrate quality, color, and texture of both exposed-to-view surface finish and finish of panel surfaces that will be concealed by other construction. Obtain approval prior to submission of sample panels. Exterior texture is to be a fine sand finish in a light brown color to match other buildings in the area. The interior face of the wall panels shall be smooth and white in color.

1.12.3 Required Records

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

1.12.4 Pre-Installation Meeting

Hold a meeting at the job site with representative of the manufacturer and the applicator prior to application of water repellents and all other trades that may be effected by work of this section. Notify the Contracting Officer at least 3 days in advance of the time of the meeting.

1.13 TOLERANCES

Dimensions of the finished panel, at the time of erection in the structure, must conform to the tolerances for precast, non-prestressed elements in PCI MNL-117, unless otherwise specified by the Architect.

PART 2 PRODUCTS

2.1 CONCRETE

2.1.1 Contractor-Furnished Mix Design

ACI 211.1 and ACI 301. The Contractor must submit the mix design report giving the maximum nominal coarse aggregate size, the proportions of all ingredients and the type and amount of any admixtures that will be used in the manufacture of each strength and type of concrete, a minimum of sixty days prior to commencing operations. Provide mix proportion data using at least three different water-cementitious material ratios for each type of mixture, which produce a range of strength encompassing those required for each type of concrete required. Plot a curve for each concrete mixture, showing the relationships between water-cementitious material ratios and compressive strengths. Maximum permissible water-cementitious material ratio must be that value not exceeding the maximum water-cementitious material ratio specified, indicated by the curve to produce a design minimum laboratory compressive strength at 28 calendar days not less than that specified. The mix design report is to contain the project name and number, date, name of Contractor, name of precast concrete wall panel manufacturer, name of concrete testing service, use of concrete mixture (facing or backing), source of concrete aggregates for each mixture. Submit certified copies of laboratory test reports, including mill tests and all other test data, for portland cement, blended cement, pozzolan, ground granulated blast furnace slag, silica fume, and aggregates. The statement must be accompanied by test results from an approved testing laboratory, certifying that the proportions selected will produce concrete of the properties required. Make no substitutions without additional tests to verify that the concrete properties are satisfactory. Concrete must have a 28-day compressive strength of 4500 psi.

If, the compressive strength falls below that specified, adjust the mix proportions and water content and make necessary changes in the temperature, moisture, and curing procedures to secure the specified strength. Notify the Contracting Officer of all changes.

2.1.2 Exposed-to-View Facing Mixture

Provide aggregates for exposed-to-view facing mixture; white, gray, or buff portland cement or a blend of two or more portland cements; air-entraining admixture; and water. Provide exact proportions of facing mixture to produce concrete having the specified properties and capable of obtaining the approved surface color and finish.

2.1.3 Backing Mixture

Provide the approved mix design.

2.2 MATERIALS

2.2.1 Material Sustainability Criteria

For products in this section, where applicable and to extent allowed by performance criteria, provide and document the following in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING:

a. Recycled content for fly ash and pozzolan

b. Recycled content for Ground Iron Blast-Furnace Slag

c. Recycled content for Silica Fume

2.2.2 Fine Aggregates

ASTM C33/C33M. The optional method of reducing the No. 50 and No. 100 sieve aggregates does not apply. The restriction to use only fine aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply.

2.2.3 Coarse Aggregate

ASTM C33/C33M, Size No. 57 , Class 5S. The restriction to use only coarse aggregates that do not contain any materials that are deleteriously reactive with alkalis in cement does apply. Aggregate must not contain slag or crushed concrete.

2.2.4 Exposed Aggregate

Fine aggregate will be brown quartz natural sand or stone screenings, or manufactured sand produced from brown quartz. Aggregate must be free of substances that change color on oxidation. Color must conform to the approved sample.

2.2.5 Cementitious Materials

For exposed concrete, use one manufacturer and one source for each type of cement, ground slag, fly ash, and pozzolan.

2.2.5.1 Fly Ash

ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed 6 percent.

Add with cement. Fly ash content must be a minimum of 20 percent by weight of cementitious material, provided the fly ash does not reduce the amount of cement in the concrete mix below the minimum requirements of local building codes. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C311/C311M. Evaluate and classify fly ash in accordance with ASTM D5759.

2.2.5.2 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirement for uniformity.

2.2.5.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age must be at least 95 percent of the control specimens.

b. The average particle size must not exceed 6 microns.

c. The sum of SiO_2 + Al_2O_3 + Fe_2O_3 must be greater than 77 percent.

2.2.5.4 Ground Granulated Blast-Furnace Slag

ASTM C989/C989M, Grade 100 or120. Slag content must be a minimum of 40 percent by weight of cementitious material.

2.2.5.5 Portland Cement

Provide cement that conforms to ASTM C150/C150M, Type II OR Type II having a tricalcium aluminate content of less than 5 percent, or meeting the optional physical requirement for sulfate expansion for Type V cement on Table 4, ASTM C150/C150M OR Type II blended with a pozzolan meeting the requirements of ASTM C618, Type F.

Supplier must certify that no hazardous waste is used in the fuel mix or raw materials.

2.2.5.6 Blended Cements

a. Blended cements must conform to ASTM C595/C595M Type IP, IS, or IL or ASTM C1157/C1157M Type GU

b. Slag cement added to the Type IS blend must meet ASTM C989/C989M.

c. The pozzolan added to the Type IP blend must be ASTM C618 Class F,or Class C and must be interground with the cement clinker. The manufacturer must state in writing that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. The percentage and type of pozzolan used in the blend must not change from that submitted for the aggregate evaluation and mixture2.2.6 Admixtures

ASTM C260/C260M for air-entraining admixtures. Other admixtures: ASTM C494/C494M. Certify that admixtures are free of chlorides. Coloring Admixture: ASTM C979/C979M, synthetic or natural mineral oxide or colored water reducing admixtures, temperature stable, and non-fading. Certify that coloring admixtures are free of chlorides.

2.2.7 Water

Water must comply with the requirements of ASTM C1602/C1602M. Minimize the amount of water in the mix. Improve workability by adjusting the grading rather than by adding water. Water must be potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete. Submit test report showing water complies with ASTM C1602/C1602M.

2.2.8 Reinforcement

All exposed steel must be phosphate treated, primed, and coated to prevent rust.

2.2.8.1 Reinforcing Bars

ACI 301 unless otherwise specified. ASTM A615/A615M, Grade 60.

2.2.8.2 Welded Wire Reinforcement

ASTM A1064/A1064M.

2.2.8.3 Supports for Concrete Reinforcement

Include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening in place in accordance with PCI MNL-117.

2.2.9 Prestressing Strands

Prestressing strands need to conform to ASTM A416/A416M Grade 270.

2.2.10 Tie Wire

Tie wire must be soft monel or 18-8 stainless steel.

2.2.11 Plates, Angles, Anchors and Embedment

ASTM A36/A36M, ferrous metal plate connectors for attachment to the structural framing using manufacturer standard construction procedures. Headed studs will use 60,000 psi steel with construction conforming to AWS D1.1/D1.1M, Type B. Deformed bar anchors must conform to ASTM A1064/A1064M. Coat steel items, other than stainless, with a rust-inhibiting paint or provide hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

Furnish and install anchors, inserts, lifting devices, and other accessories which are to be embedded in the precast units in accordance with the approved detail drawings. Embedded items must be accurately positioned in their designed location, and have sufficient anchorage and embedment to satisfy design requirements.

2.2.12 Form Release Agent

Release agent must be manufacturer's standard non-staining type.

2.2.13 Grout

Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107/C1107M and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218/C1218M.

2.3 CAST-IN EMBEDDED ITEMS AND CONNECTORS

2.3.1 Inserts

2.3.1.1 Threaded-Type Concrete Inserts

ASTM A47/A47M, Grade 32510 or 35018, or may be medium strength cast steel conforming to ASTM A27/A27M, Grade U-60-30. Provide galvanized ferrous casting having enlarged base with two nailing lugs minimum length less than the thickness of panel less 3/4 inch, and internally threaded to receive 3/4 inch diameter machine bolt. Ferrous castings must be ferritic malleable iron. Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

2.3.1.2 Wedge-Type Concrete Inserts

Provide galvanized, box-type ferrous castings with integral anchor loop at back of box to accept 3/4 inch diameter bolts having special wedge-shaped head. Provide ferrous castings ASTM A47/A47M, Grade 32510 or 35018, ferritic malleable iron or ASTM A27/A27M, Grade U-60-30, medium-strength cast steel. Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

2.3.1.3 Slotted-Type Concrete Inserts

Provide pressed steel plate, welded construction, box type with slot to receive 3/4 inch diameter square head bolt, and provide lateral adjustment of bolt. Length of insert body, less anchorage lugs, must be 4 1/2 inches minimum. Provide insert with knockout cover. Steel plate must be 1/8 inch minimum thickness, ASTM A283/A283M, Grade C. Provide inserts hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.

2.3.1.4 Flashing Reglets

Reglets must be sheet metal open-type with continuous groove not less than 1-1/8 inches deep by 3/16-inch wide at opening and sloped upward, designed to anchor snap-lock counter flashing.

Metal must be minimum 0.011-inch thick conforming to ASTM A666, Type 302 or 304, No. 1 finish, soft temper.

Metal is to be 26-gage galvanized steel sheet conforming to ASTM A653/A653M, G90.

2.3.2 Connection Devices

2.3.2.1 Clip Angles

ASTM A36/A36M steel, galvanized after fabrication in accordance with ASTM A153/A153M.

2.3.2.2 Ferrous Casting Clamps

ASTM A47/A47M, Grade 32510 or Grade 35018 malleable iron or cast steel, or ASTM A27/A27M, Grade 60-30, cast steel casting, hot-dip galvanized in accordance with ASTM A153/A153M.

2.3.2.3 Threaded Fasteners

Provide galvanized machine bolts, washers and, when required, nuts.

a. Bolts: ASTM A449, 3/4 inch diameter machine bolts with hexagon head.

b. Washers: ASME B18.21.1, medium or heavy lock-spring washers.

c. Nuts: ASTM A563, Grade C, heavy, hexagon-type nuts.

d. Square Nuts: ASTM A563, Grade A, plain, square-type nuts where required for slotted-type concrete inserts.

2.4 PRECAST ELEMENT FABRICATION

2.4.1 Formwork and Fabrication Tolerances

Provide forms and form-facing materials of wood, metal, plastic, or other approved material to produce concrete having the specified finish. Construct forms mortar-tight and of sufficient strength to withstand all pressures due to concrete placing operations and temperature changes. Brace and stiffen against deformation. Provide form liners where required to produce indicated finish. Provide dimensional tolerances per PCI MNL-117.

2.4.2 Reinforcement

ACI 301. Place reinforcing bars and welded wire reinforcement. Secure in position with tie wires, bar supports, and spacers.

2.4.3 Preparation for Placing Concrete

Remove hardened concrete, excess form parting compound, standing water, ice, snow, or other deleterious substances from form interiors and reinforcement before concrete placement. Secure reinforcement and embedded items.

2.4.4 Concrete Mixing and Conveying

2.4.4.1 Batch Plant, Mixer, Mixing, and Measuring of Materials

ASTM C94/C94M.

2.4.4.2 Conveying

Prevent segregation and loss of materials.

2.4.5 Concrete Placing

ACI 304R. Deposit concrete in the forms continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the precast concrete units. Place concrete at a constant temperature of between 50 and 90 degrees F throughout fabrication of each unit. Make temperature of forms or molds the same as or close to the concrete temperature. For hot or cold weather, use methods recommended by ACI 305R and ACI 306.1. Vibrate and consolidate concrete to prevent segregation and to produce a high-density concrete free of honeycomb and rock

pockets. When specified, the exposed-to-view facing mixture is required to be a minimum thickness of 3/4 inches. Place backing mixture before facing mixture attains initial set.

2.4.6 Identification Markings

Permanently mark each precast unit to indicate pick-up points, location, orientation in the building, and date of casting. Identification markings need to correlate with approved detail drawings. Do not locate in exposed-to-view finished surfaces.

2.4.7 Finishing

2.4.7.1 Unformed Concealed Surfaces (Standard Smooth Finish)

Provide a trowel finish. Level surface with a straightedge, and strike off. After surface water has disappeared, float and trowel surface. Provide smooth finished surface, free of trowel marks, and uniform in texture and appearance.

2.4.7.2 Smooth, Exposed-to-View Surfaces

Provide a standard smooth finish to all exposed-to-view surfaces of panels, unless otherwise indicated. Provide a concrete surface having the texture imparted by a steel form or other approved smooth surfaces form-facing material.

2.4.7.3 Exposed Aggregate Finish

Provide for exposed-to-view surfaces of panels, including chamfers, edges, recesses, and projections, unless otherwise indicated. Provide standard smooth finish with outer skin of mortar removed, before concrete has hardened, and exposing coarse aggregate. A chemical retarder may be used on exposed face to facilitate removal of mortar. Match finish of the approved surface finish sample. Expose aggregates as soon after concrete placing as practicable .

2.4.7.4 Other Surfaces

Surfaces of precast units not exposed to view or not otherwise indicated to be finished are to be finished in accordance with ACI 301 for a Surface Finish of 1.0.

2.4.8 Curing

Provide moist or steam curing or curing compound. Do not remove precast units from forms; prevent moisture loss and maintain 50 degrees F minimum for at least 24 hours after finishing. Maintain precast units in a surface damp condition at 50 degrees F minimum until concrete has attained 75 percent minimum of the design compressive strength. Do not use steam curing with wood forms or in connection with chemically retarded exposed aggregate surfaces.

2.4.9 Repair of Surface Defects

Cut out defective areas to solid concrete, with edges of cuts perpendicular to the surface of the concrete, and clean thoroughly. Dampen area to be patched and brush-coat with nonshrink grout or bonding agent. Patch the surface in accordance with procedures previously

submitted by the Contractor and approved by the Contracting Officer. Where exposed to view, the patches, when dry, needs to be indistinguishable from the surrounding surfaces.

2.4.9.1 Smooth, Concealed Surfaces

Acceptable defective area will be limited to holes left by rods and other temporary inserts, and to honeycomb or rock pockets of 1/4 inch diameter maximum. Remove fins and other projections on the surfaces.

2.4.9.2 Exposed-to-View Surfaces

The combined area of acceptable defective areas must not exceed 0.2 percent of the exposed-to-view surface area and will be limited to holes of 1/4 inch diameter maximum.

2.4.10 Stripping

Do not remove precast concrete units from forms until units develop sufficient strength to safely strip the formwork and to remove the precast concrete units from the forms to prevent damage to the units from overstress or chipping.

2.4.11 Built-In Anchorage Devices

Accurately position and securely anchor all anchorage devices. Openings in anchorage devices must be filled temporarily to prevent entry of concrete.

2.4.12 Lifting Devices

Lifting devices must be provided, and designed for a safety factor of 4, which includes 100 percent impact. Do not use brittle material.

2.4.13 Finishing for Formed Surfaces

Upon removal of forms, repair and patch defective areas. Where the finished surface will be exposed to view, the combined area of defective areas must not exceed 0.2 percent of the surface and will be limited to honeycomb or rock pockets not deep enough to expose the reinforcement. Where the finished surface will be concealed by other construction, defective areas are limited to holes left by the rods and other temporary inserts and honeycomb or rock pockets not deep enough to expose the reinforcement. Defective areas must be cut out to solid concrete, cleaned, and patched with grout. Where concrete surface will be exposed to view, the patches, when dry, must be indistinguishable from the surrounding surfaces.

Exposed-aggregate finish must match the finish of the approved sample. Aggregates in exposed-to-view surfaces will be exposed as soon after concrete placing as practical by power sanders, wire brushes, or other acceptable methods. Give surfaces one or more washings with a dilute solution of muriatic acid, then washed with fresh, clean water to remove all traces of the acid.

Deficiencies requiring rejection of Precast:

Exposed-to-view surfaces that do not match the color, aggregate size and distribution, and texture of the approved sample

Exposed-to-view surfaces that contain defects that affect the appearance of the finish, such as cracks, spalls, honeycomb, rock pockets, or stains and discoloration of aggregate or matrix that cannot be removed by cleaning

Concealed surfaces that contain cracks in excess of 0.01 inch wide, cracks that penetrate to the reinforcement regardless of width, honeycomb, rock pockets, and spalls except minor breakage at corners and edges

2.5 JOINT MATERIALS

Gasket must be elastomeric material, premolded to cross section indicated.

Material must be a vulcanized closed-cell expanded chloroprene conforming to ASTM D1056, Grade No. 2A2, with the following additional properties:

a. Brittleness temperature will be minus 40 degrees F when tested in accordance with ASTM D746.

b. Flammability resistance needs to be self-extinguishing when tested in accordance with ASTM D635.

c. Resistance to ozone must be "no cracks" after exposure of a sample, at 20 percent elongation, to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 104 degrees F when tested in accordance with ASTM D1149.

2.6 MISCELLANEOUS ARCHITECTURAL PRECAST CONCRETE SYSTEMS

2.7 BEARING PADS

Submit product data for all bearing pads being used.

2.7.1 Elastomeric

AASHTO M 251, for plain neoprene bearings.

2.7.2 Hardboard (Interior Only)

AHA A135.4, class as specified by the precast manufacturer.

2.7.3 Random-Oriented, Fiber-Reinforced Elastomeric Pads

Preformed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer according to ASTM D2240. Capable of supporting a compressive stress of 3000 psi with no cracking, splitting or delaminating in the internal portion of the pad.

2.7.4 Cotton-Duck-Fabric-Reinforced Elastomeric Pads

Preformed, horizontally layered cotton-duck fabric bonded to an elastomer. Surface hardness of 80 to 100 Shore A durometer according to ASTM D2240. Conforming to Division II, Section 18.10.2 of AASHTO LRFD Bridge Design Specifications or Military Specification MIL-C-882E.

2.7.5 Frictionless Pads

Polytetrafluoroethylene (PTFE), glass-fiber reinforced, bonded to stainless or mild-steel plates, or random-oriented, fiber-reinforced elastomeric pads, of type required for in-service stress.

2.7.6 High-Density Plastic

Multimonomer, nonleaching, plastic strip capable of supporting loads with no visible overall expansion.

2.8 INSULATED PANEL ACCESSORIES

2.8.1 Polyisocyanurate Board Insulation

Polyisocyanurate board insulation: faced, rigid, cellular polyisocyanurate thermal insulation with core formed by using hydrocarbons as blowing agents; square edged; complying with ASTM C1289, Type I. Compressive resistance: 25 psi minimum at yield or at 10 percent deformation per ASTM D1621. Water absorption: 0.05 percent maximum by volume per ASTM C272/C272M. Maximum use temperature of 190°F. Polyisocyanurate board stock shall be faced on each side with a kraft/aluminum/polyester facer providing a water vapor permeance less than 0.03 perm per ASTM E96/E96M. Unexposed metallic facing that is not susceptible to corrosion or chemical reaction with the concrete. Provide precisely cut connector holes to identify connector placements at designated spacing through insulation board surfaces. Provide insulation a minimum thickness of 3 inches or as indicated.

PART 3 EXECUTION

3.1 PREPARATION

Deliver anchorage devices to the site in time to be installed before the start of concrete placing or during steel erection. Contractor must provide setting drawings, instructions, and directions for the installation of anchorage devices.

3.2 EXAMINATION

Do not begin installation until supporting structures have been properly prepared.

Verify that all parts of the supporting structure are complete and ready to receive the precast units and that site conditions are conducive to proper installation.

If support structure is the responsibility of another installer, notify Contracting Officer of unsatisfactory preparation before proceeding.

3.3 INSTALLATION

Install precast concrete units and accessories in accordance with approve detail drawings and descriptive data, and as specified below.

3.3.1 Building Framing System

Provide supporting members, including anchorage items attached to or embedded in building structural elements, prior to placement of precast

units.

3.3.2 Concrete Strength at Time of Precast Unit Installation

Do not install precast units until concrete has attained the minimum laboratory compressive strength at 28 calendar days specified.

Do not install precast units before 28 calendar days from the date of casting unless approval has been obtained to make one compressive strength test, ASTM C39/C39M, and one flexural strength test using simple beam with third-point loading, ASTM C78/C78M, on field cured concrete test specimens, ASTM C31/C31M, for each individual precast unit to determine the strength of the concrete.

3.3.3 Erection

Erect precast units in accordance with the detail drawings and without damage to other units or to adjacent members. Set units true to alignment and level, with joints properly spaced and aligned both vertically and horizontally. Erection tolerances must be in accordance with the requirements of PCI MNL-117 and PCI MNL-122. As units are being erected, shims and wedges will be placed as required to maintain correct alignment. After final attachment, grout precast units as shown. After erection, clean and touch-up welds and abraded surfaces of steel with a zinc-rich paint. Welds must be made by a certified welder in accordance with the manufacturer's erection drawings. Finish pickup points, boxouts, inserts, and similar items to match adjacent areas after erection. Erection of precast units must be supervised and performed by workmen skilled in this type of work. Welding and the qualifications of welders must be in accordance with AWS D1.1/D1.1M.

3.3.4 Erection Tolerances

Erect architectural precast concrete units level, plumb, square and in alignment without exceeding the noncumulative erection tolerances of PCI MNL-117, Appendix I.

3.3.5 Joints

Joint widths between precast units will be as specified unless otherwise indicated.

3.3.5.1 Joint Sealing

Joint sealing will be as specified in Section 07 92 00 JOINT SEALANTS.

3.3.6 Protection

Protect exposed-to-view facing from staining and other damage from subsequent operations. Do not allow laitance to penetrate, stain, or harden on exposed surfaces.

3.4 DEFECTIVE WORK

Repair precast concrete units damaged during erection as soon after occurrence as possible or replaced, as directed, using approved procedures. All repairs to precast concrete units must match the adjacent surfaces in color and texture, as approved. Unless otherwise approved, repair procedures will conform to PCI MNL-117.

3.5 JOINTS AND GASKETS

Joints between precast units must be the width indicated and within limits of installation tolerances.

Install gaskets in joints as indicated, continuous throughout the joint length, and compressed at least 25 percent by volume.

3.6 INSPECTION AND ACCEPTANCE PROVISIONS

3.6.1 Dimensional Tolerances

Precast units having dimensions outside the limits for fabrication tolerances will be rejected.

3.6.2 Surface Finish Requirements

Precast units will be rejected for the following surface finish deficiencies:

a. Exposed-to-view surfaces that do not match the color, aggregate size and distribution, and texture of the approved sample

b. Exposed-to-view surfaces that contain defects that affect the appearance of the finish, such as cracks, spalls, honeycomb, rock pockets, or stains and discoloration of aggregate or matrix that cannot be removed by cleaning

c. Concealed surfaces that contain cracks in excess of 0.01 inch wide, cracks that penetrate to the reinforcement regardless of width, honeycomb, rock pockets, and spalls except minor breakage at corners and edges

3.6.3 Strength of Precast Units

Strength of precast concrete units will be considered potentially deficient if the units fail to comply with the requirements that control the strength of the units, including the following conditions:

a. Failure to meet compressive strength tests

b. Reinforcement not conforming to the requirements specified

c. Concrete curing and protection of precast units against extremes of temperature during curing not conforming to the requirements specified

d. Precast units damaged during handling and erection

3.6.4 Testing Precast Units for Strength

When there is evidence that the strength of precast concrete units does not meet specification requirements, cores drilled from hardened concrete for compressive strength determination must be made in accordance with ASTM C42/C42M and as follows:

a. Take at least three representative cores from the precast-concrete units that are considered potentially deficient.

b. Test cores with the saturated surface dry.

c. Strength of cores will be considered satisfactory if their average is equal to or greater than 90 percent of the 28-day design compressive strength of 6 by 12 inch cylinders.

Submit test reports on the same day that tests are made. Reports must contain the project name and number, date, name of contractor, name of precast concrete wall units manufacturer, name of concrete-testing service, identification letter and number of units represented by core tests, nominal maximum size of aggregate, design compressive strength of concrete at 28 calendar days, compressive breaking strength and type of break, length of core test specimen before capping, compressive strength after correcting for length diameter ratio, direction of application of the load on the core test specimen with respect to the horizontal plane of the concrete as placed, and the moisture condition of the core test specimen at time of testing.

If the results of the core tests are unsatisfactory or if core tests are impractical to obtain, a static load tests of a precast unit will be evaluated in accordance with ACI 318.

Replace precast units used for core tests or static load tests with units that meet the requirements of this section.

3.7 SAMPLING AND TESTING

3.7.1 Rejection

Precast units in place may be rejected for any one of the following product defects or installation deficiencies remaining after repairs and cleaning have been accomplished. "Visible" means visible to a person with normal eyesight when viewed from a distance of 20 feet in broad daylight.

a. Nonconformance to specified tolerances.

b. Air voids (bugholes or blowholes) larger than 3/8 inch diameter.

c. Visible casting lines.

d. Visible from joints.

e. Visible irregularities.

f. Visible stains on precast unit surfaces.

g. Visible differences between precast unit and approved sample.

h. Visible non-uniformity of textures or color.

i. Visible areas of backup concrete bleeding through the facing concrete.

j. Visible foreign material embedded in the face.

k. Visible repairs.

l. Visible reinforcement shadow lines.

m. Visible cracks.

n. Precast units that are damaged during construction operations.

3.7.2 Field Quality Control

Perform field inspection of precast unit connections. Notify the Contracting Officer in writing of defective welds, bolts, nuts and washers within 7 working days of the date of inspection. All defective connections or welds are to be removed and re-welded or repaired as required by the Contracting Officer.

3.7.2.1 Welded Connection Visual Inspection

AWS D1.1/D1.1M, furnish the services of AWS-certified welding inspector for erection inspections. Welding inspector must visually inspect all welds and identify all defective welds.

3.8 CLEANING

Clean exposed-to-view surfaces of precast units thoroughly with detergent and water; use a brush to remove foreign matter. Remove stains that remain after washing in accordance with recommendations of the precast manufacturer. Surfaces must be clean and uniform in color. Include precast concrete wall panel manufacturer's written recommendations for installation and cleaning.

-- End of Section --

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SECTION 05 05 20

POST-INSTALLED CONCRETE AND MASONRY ANCHORS
05/22, CHG 1: 08/24

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 355.2	(2007) Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary
ACI 355.4	(2011) Qualification of Post-Installed Adhesive Anchors in Concrete (ACI 355.4) and Commentary

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 APPLICABILITY

This guide specification covers the requirements for all anchors that are post-installed into hardened concrete, concrete masonry, or brick. This guide specification does not cover through bolts, powder or pneumatic actuated nails, or cast in anchors. Refer to Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS for requirements of through bolts, powder or pneumatic actuated nails, or cast in anchors.

1.3 DEFINITIONS

1.3.1 Anchor

"Anchor" includes steel elements post-installed into hardened concrete, concrete masonry, or brick and used to transmit applied loads.

1.3.2 Periodic Special Inspections

"Periodic Special Inspection" as used herein means that, as a minimum, the Post-Installed Anchor Special Inspector must perform inspections in accordance with this specification.

1.3.3 Continuous Special Inspections

"Continuous Special Inspection" as used herein means that the Post-Installed Anchor Special Inspector observes the drilling and cleaning of holes, the injection of adhesive into the holes, and the insertion of anchors into the holes. When applicable for the type of installation, or as indicated in the project drawings, "Continuous Special Inspection" also includes observation of measures to secure the anchor during the adhesive curing period.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installer Qualifications; G, RO

Post-Installed Anchor Special Inspector Qualifications; G, RO

SD-03 Product Data

Mechanical Anchors in Concrete

Adhesive Anchor System in Concrete

Mechanical and Adhesive Anchors in Masonry

Non-Shrink, Non-Metallic Grout

SD-06 Test Reports

Post-Installed Anchor Special Inspections Report; G, RO

SD-07 Certificates

Post-Installed Anchor Certification; G, RO

SD-08 Manufacturer's Instructions

Manufacturer's Printed Installation Instructions;

Non-Shrink, Non-Metallic Grout;

Manufacturer's Safety Data Sheets

1.5 QUALITY ASSURANCE

Perform all work in accordance with EM 385-1-1 and all manufacturer's instructions and recommendations. To protect personnel from overexposure to toxic materials, conform to the applicable manufacturer's Safety Data Sheets (SDS) or local regulation. Submit the SDS for epoxies and other potentially hazardous materials.

1.5.1 Qualifications

The submittals must identify individuals who will be working on this contract and their relevant experience and training. Do not make changes in approved personnel without prior approval of the Contracting Officer.

1.5.1.1 Installer Qualifications

Each worker engaged in the installation of post-installed anchors must have satisfactorily completed an applicable certification program or equivalent instruction program through the manufacturer or manufacturer's representative for all anchoring products they will install. A manufacturer's representative must train all installers per the installation instructions as listed in the ICC-ES Evaluation Report for the anchor being installed. Training must consist of a review and performance test of the complete installation process, including but not limited to:

(1) Hole drilling procedure

(2) Hole preparation & cleaning technique

(3) Adhesive injection technique & dispenser training / maintenance

(4) Anchor/threaded rod preparation and installation

(5) Rebar dowel preparation and installation

(6) Proof loading/torquing

(7) Installation in horizontal and upward orientations

Submit certification for each worker showing that they have completed the above training within three years prior to onsite work. Certification must include organization or manufacturer's name, instructor's name and qualifications, trainee's name, list of instruction received, date of instruction, and confirmation of successful performance tests.

1.5.1.2 Post-Installed Anchor Special Inspector Qualifications

The Contractor must retain the services of a third party Special Inspector independent of the installing contractor and manufacturer. The individual(s) who perform special inspections for post-installed anchors must meet all Installer Qualification requirements and have a minimum of 3 years of experience as a Special Inspector on previous projects involving similar scope of work. Submit resumes, pertinent information, past experience, and training.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Packing, Shipping, Handling, and Unloading

Deliver products to job site in manufacturer's or distributor's original packaging undamaged, complete with installation instructions. Inspect materials delivered to site for damage. Unload and store with minimal handling.

1.6.2 Storage

Protect, store, and handle materials in accordance with manufacturer's recommendations to prevent damage or deterioration. Do not allow chemical materials to freeze. Remove materials that have not be stored in accordance with the manufacturer's recommendations, including expired materials, from the job site.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Post-Installed Anchors

Provide anchors of the type, effective embedment, and diameter indicated on contract drawings. Minimum spacing and concrete edge distances must be as shown on contract drawings. Design values listed must be as tested according to ASTM E488/E488M for the substrate type, substrate moisture condition, concrete aggregate type (normal weight or lightweight concrete), and concrete/masonry strength. Minimum ultimate strength tension and shear values must be as indicated on contract drawings. If more than one type of anchor is to be used on a project, clearly indicate on the submittal where each type of anchor will be used.

2.1.1.1 Post-Installed Anchor Certification

Submit product information with recommended design values and physical characteristics for each type anchor shown on the drawings.

Provide certified test reports showing compliance with specified performance characteristics and physical properties. Anchors must have one of the following certifications:

(1) ICC-ES Evaluation Report indicating conformance with current applicable ICC ES Acceptance Criteria

(2) Third party Evaluation Report in conformance with ACI 355.2 or ACI 355.4, as applicable. Third party must be accredited under ISO/IEC 17025 by a recognized accreditation body conforming to the requirements of ISO/IEC 17011 in accordance with ACI 355.4."

2.1.1.2 Manufacturer's Printed Installation Instructions

Submit manufacturer's instructions for each anchor type shown on the drawings.

2.1.1.3 Mechanical Anchors in Concrete

Anchors must have been tested and qualified for performance in cracked and uncracked concrete in accordance with ACI 355.2.

Anchors must be galvanized in accordance with ASTM A153/A153M or stainless steel in accordance with ASTM A193/A193M unless otherwise indicated.

2.1.1.4 Adhesive Anchor System in Concrete

Use an adhesive to bond steel anchors to concrete. The adhesive must be a moisture insensitive, structural adhesive. Anchors must have been tested and qualified for performance in cracked and uncracked concrete, horizontal and overhead applications, and long term creep in accordance with ACI 355.4.

Threaded rod anchors must meet the requirements of ASTM F1554 Grade 55. Threaded rods must be galvanized in accordance with ASTM A153/A153M or stainless steel in accordance with ASTM A193/A193M unless otherwise indicated. Reinforcing bars must meet the requirements of ASTM A615/A615M Grade 60.

Adhesive anchors must have the below characteristic bond strengths for uncracked and cracked concrete in 650 psi and 200 psi concrete with maximum short term temperatures of 110 degrees F and maximum long term temperatures of 175 degrees F:

ANCHOR	Tau,uncr (characteristic bond strength, uncracked concrete)	Tau,cr (characteristic bond strength, cracked concrete)
	(psi)	(psi)
" diameter threaded rod		
#___ reinforcing bar		

2.1.1.5 Mechanical and Adhesive Anchors in Masonry

Anchors must have been tested and qualified, by a third party, specifically for performance in hollow concrete masonry,filled concrete masonry and brick to match the project's actual base material.

Adhesives must be moisture insensitive, low creep, structural adhesive. Threaded rods must meet the requirements of ASTM F1554 Grade 55

Anchors must be galvanized in accordance with ASTM A153/A153M or stainless steel in accordance with ASTM A193/A193M unless otherwise indicated.

2.2 EQUIPMENT

Assemble at the site of the work, sufficient equipment that is dependable, appropriate and adequate to accomplish the work specified. Maintain the

equipment in good working condition.

PART 3 EXECUTION

3.1 ANCHORING AND REINFORCING

Install anchors in accordance with the spacing and edge clearances indicated on the drawings. Anchor capacity is also highly dependent on proper installation. Follow all manufacturer and Evaluation Report installation instructions.

3.1.1 Drilling and Installing Mechanical Anchors

Drill holes for anchors using drilling equipment and bits suitable for the intended purpose, in accordance with Manufacturer's published installation instructions. Diameter of holes must be as recommended by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes must be drilled perpendicular to the concrete surface. Deviations more than 6 degrees from perpendicular are not acceptable. Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Mechanical anchors must not be installed in concrete that is less than 7 days old.

Clean holes, install anchors and set anchors in place in accordance with the manufacturer's recommendations. Protect threads and anchor from damage during anchor installation. Ensure proper embedment and placement in accordance with contract documents and all other work. Aim wedges away from any concrete edges that are less than 9 inches from centerline of hole.

Tighten nuts against smooth washers to the manufacturer's recommended torque, using a calibrated torque wrench. Following attainment of 10 percent of the specified torque, 100 percent of the specified torque must be reached within 7 or less complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor must be removed and replaced unless otherwise directed by the Engineer of Record.

3.1.2 Drilling and Installing Adhesive Anchors

Drill holes for anchors using drilling equipment and bits suitable for the intended purpose, in accordance with Manufacturer's Printed Installation Instructions and Evaluation Report installation instructions. Diameter of holes must be as recommended by the anchor manufacturer. Unless otherwise shown on the drawings, all holes must be drilled perpendicular to the concrete surface. Deviations more than 10 degrees from perpendicular are not acceptable. Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Adhesive anchors must not be installed in concrete that is less than 21 days old.

Clean holes, place grout, and install anchors in accordance with anchor manufacturer's recommendations. Remove excess adhesive after the anchor has been set in place. Remove spills on adjacent surfaces. When installing resin cartridges or capsules in submerged conditions, place properly proportioned resin material in bottom of hole using a mixing tube prior to inserting the cartridge or capsule. Protect threads and anchor from damage during anchor installation. Ensure proper embedment and placement in accordance with contract documents and all other work. Do

not disturb or load anchors before manufacturer specified cure time has elapsed.

Adhesives must be stored at temperatures prescribed by the manufacturer and must not be used beyond the expiration date.

3.1.3 Unused or Repairs to Drilled Holes

Any holes made for anchors that are not used must be filled with non-shrink, non metallic grout suitable for the orientation and size of hole and have a minimum compressive strength of 4000 psi. Repair must completely fill hole and be flush with existing concrete or masonry. Place in accordance with manufacturer's recommended instructions. Final anchor positions must not be within1 inch of repair patches.

3.2 EMBEDDED ITEMS

Existing reinforcing bars or other embedded items in the structure may conflict with specified anchor locations. Existing reinforcing and embedded items must not be damaged during installation of post-installed anchors.

The contractor must review the project drawings and must use Radar detection systems (such as Hilti Ferroscan), X-Ray, or other appropriate means to accurately locate the position of existing reinforcing bars and embedded items at the locations of the anchors in the field. Scanning method must provide enough accuracy and precision to locate the space between rebar. Structural integrity of existing concrete or masonry must not be impaired by investigating method.

Create a template at each anchor connection location prior to fabricating holes in connection plates. Template must be made by locating existing reinforcing with an approved reinforcement detection system.

3.3 TESTS AND INSPECTIONS

3.3.1 Mechanical Anchors

For mechanical anchors, periodic special inspections are required. Inspections must be in accordance with ICC IBC and the Evaluation Report.

Mechanical Anchors must be inspected during installation, to verify anchor type, anchor dimensions, base material type, drill bit, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, base material thickness, base material age, effective embedment, tightening torque, adherence to the manufacturer's printed installation instructions, and any additional items recommended in the Evaluation Report.

For mechanical anchors whose strength is dependent on a minimum installation torque, the installer under the supervision of the Special Inspector must torque test the anchors with a calibrated torque wrench. Perform torque testing immediately on the first three anchors of each type and size, for each installer, and a minimum of 10 percent of randomly selected anchors. Anchor selection will be determined by the Contracting Officer.

For mechanical anchors whose strength is not dependent on a minimum installation torque, the Special Inspector must perform proof loading on the first three anchors of each type and size, for each installer and a

minimum of 10 percent of randomly selected anchors. Anchor selection will be determined by the Contracting Officer. Perform confined tension proof load testing in accordance with ASTM E488/E488M. Use incremental loading for tensile test. Maintain proof load for a minimum of 10 seconds. Consider anchors to have failed if displacement exceeds 0.1 inch D/10, where D is the nominal anchor diameter, or if any of the failure modes listed in ASTM E488/E488M occur.

Proof loads must be the minimum of the value shown on the Drawings.

3.3.2 Adhesive Anchors

For adhesive anchors, periodic special inspection are required as a minimum. Where adhesive anchors are used to resist sustained tension in horizontal or upwardly inclined orientations, or where the findings of the Evaluation Report for the adhesive anchor product require it, continuous special inspection is needed. Inspections must be in accordance with ICC IBC and the Evaluation Report.

Adhesive anchors must be inspected during installation, to verify anchor type, anchor dimensions, base material type, base material age, drill bit, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, base material thickness, effective embedment, tightening torque, adhesive mixing, filling of the hole with adhesive, adherence to the manufacturer's printed installation instructions, and any additional items recommended in the Evaluation Report.

The Special Inspector must perform proof loading on the first three anchors of each type and size, for each installer, and a minimum of 10 percent of randomly selected anchors. Anchor selection will be determined by the Contracting Officer. Perform confined tension proof load testing in accordance with ASTM E488/E488M. Use incremental loading for tensile test. Maintain proof load for a minimum of 10 seconds. Consider anchors to have failed if displacement exceeds 0.1 inch D/10, where D is the nominal anchor diameter, or if any of the failure modes listed in ASTM E488/E488M occur.

Adhesive anchors and capsule anchors must not be torque tested.

Proof loads must be the minimum of the value shown on the Drawings.

3.3.3 Action Required from Failed Tests/Inspections

Immediately report failed anchor locations and test results to the Contracting Officer. Anchors that fail to meet proof/torque load or installation requirements must be regarded as malfunctioning. Do not re-use holes unless specifically allowed by manufacturer's published instructions and approved by the Post-Installed Anchor Special Inspector.

If any of the tested anchors fail to achieve the specified torque or proof load within the limits of the contract documents, test a minimum of two adjacent anchors for each anchor that fails.

Continuously special inspect and proof load/torque test any replacement anchors.

Fill unused anchor holes and patch failed anchor locations in accordance with this specification. Prior to performing the repair, the Contractor must submit to the Contracting Officer for approval, the proposed fill and

patch materials.

Additional tests, repairs, delays, or modification of work to accommodate failed tests will be at no cost to the Government.

3.3.4 Post-Installed Anchor Special Inspections Report

Report the results of all inspections weekly. Submit report as an electronic PDF file to the Contracting Officer for review by the Engineer of Record. The report must include the following:

(1) Exact locations of the inspected and tested work

(2) Inspector's name

(3) Date of inspection

(4) Summary of work completed during the inspection period

(5) Test results

(6) Statement by the Special Inspector that clearly identifies the tested anchors as being acceptable or rejected.

(7) Statement by the Special Inspector confirming that the materials and installation procedures conform with the approved contract documents and the manufacturer's published installation instructions.

3.4 DUST CONTROL

Control dust resulting from demolition to prevent the spread of dust and avoid creation of a nuisance in the surrounding area. Do not use water when it will result in, or create, hazardous or objectionable conditions such as ice, flooding, or pollution.

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SECTION 05 05 23.16

STRUCTURAL WELDING
08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel
AWS D1.4/D1.4M	(2018) Structural Welding Code - Reinforcing Steel
AWS D1.8/D1.8M	(2016) Structural Welding Code—Seismic Supplement
AWS D14.4/D14.4M	(2012) Specification for Welded Joints for Machinery and Equipment
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E709	(2021) Standard Guide for Magnetic Particle Testing

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Welding Quality Assurance Plan; G, RO

SD-03 Product Data

Welding Procedure Qualifications; G, RO

Welder, Welding Operator, and Tacker Qualification

Previous Qualifications

Pre-Qualified Procedures; G, RO

Welding Electrodes and Rods

SD-06 Test Reports

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Weld Inspection Log

SD-07 Certificates

Certified Welding Procedure Specifications (WPS)

Certified Brazing Procedure Specifications (BPS)

Certified Procedure Qualification Records (PQR)

Certified Welder Performance Qualifications (WPQ)

Certified Brazer Performance Qualifications (BPQ)

Certified Welding Inspector

Nondestructive Testing Personnel

1.3 QUALITY ASSURANCE

Except for pre-qualified (in accordance with AWS D1.1/D1.1M) and previously qualified procedures, each Contractor performing welding must record in detail and qualify the welding procedure specification for any welding procedure followed in the fabrication of weldments. Conform welding procedure qualifications to AWS D1.1/D1.1M, AWS D1.8/D1.8M and to the specifications in this section. Submit for approval copies of the welding procedure specification and the procedure qualification records for each type of welding being performed. Submission of the welder, welding operator, or tacker qualification test records is also required.

Approval of any procedure, however, does not relieve the Contractor of the sole responsibility for producing a finished structure meeting all the specified requirements. Submit this information on the forms in Annex M of AWS D1.1/D1.1M. Individually identify and clearly reference on the detail drawings and erection drawings all welding procedure specifications, or suitably key them to the contract drawings. In case of conflict between this specification and AWS D1.1/D1.1M, this specification governs.

1.3.1 General Requirements

Fabricate work in an AISC Certified Fabrication Plant, Category BU. Erect work by an AISC Certified Erector, Category CSE.

a. For Structural Projects, provide documentation of the following:

(1) Component Thickness 1/8 inch and greater: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D1.1/D1.1Mand AWS D1.8/D1.8M.

(2) Component Thickness Less than 1/8 inch: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D1.3/D1.3M.

(3) Reinforcing Steel: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D1.4/D1.4M.

b. For other applications, provide documentation of the following:

(1) Submit two copies of the Certified Welding Procedure Specifications (WPS), Certified Brazing Procedure Specifications (BPS) and Certified Procedure Qualification Records (PQR) to the Contracting Officer for review.

(2) Submit two copies of the Certified Welder Performance Qualifications (WPQ)and Certified Brazer Performance Qualifications (BPQ) to the Contracting Officer for approval within fifteen calendar days prior to any employee welding on the project material.

(3) Machinery: Qualification documents (WPS, PQR, and WPQ) in accordance with AWS D14.4/D14.4M.

1.3.2 Previous Qualifications

Welding procedures previously qualified by test in accordance with AWS D1.1/D1.1M, may be accepted for this contract without re-qualification, upon receipt of the test results, if the following conditions are met:

a. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

b. The qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.

c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.3.3 Pre-qualified Procedures

Welding procedures which are considered pre-qualified as specified in AWS D1.1/D1.1M will be accepted without further qualification. Submit for approval a listing or an annotated drawing to indicate the joints not pre-qualified. Procedure qualification is mandatory for these joints.

1.3.4 Welder, Welding Operator, and Tacker Qualification

Each welder, welding operator, and tacker assigned to work on this contract must be qualified in accordance with the applicable requirements of AWS D1.1/D1.1M, AWS D1.8/D1.8M and as specified in this section. Welders, welding operators, and tackers who make acceptable procedure qualification test welds will be considered qualified for the welding procedure used within the applicable essential variables for welder qualification.

1.3.4.1 Previous Personnel Qualifications

At the discretion of the Contracting Officer, welders, welding operators, and tackers qualified by test within the previous 6 months may be accepted for this contract without re-qualification if all the following conditions are met:

a. Copies of the welding procedure specifications, the procedure qualification test records, and the welder, welding operator, and tacker qualification test records are submitted and approved in accordance with the specified requirements for detail drawings.

b. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.3.4.2 Certificates

Before assigning any welder, welding operator, or tacker to work under this contract, submit the names and certification that each individual is qualified as specified. State in the certification the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, the date qualified, and the name of the firm and person certifying the qualification tests. Keep the certification current, on file, and furnish 3 copies.

1.3.4.3 Renewal of Qualification

Re-qualification of a welder or welding operator is required under any of the following conditions:

a. It has been more than 6 months since the welder or welding operator has used the specific welding process for which he is qualified.

b. There is specific reason to question the welder or welding operator's ability to make welds that meet the requirements of these specifications.

c. The welder or welding operator was qualified by an employer other than those firms performing work under this contract, and a qualification test has not been taken within the past 12 months. Submit as evidence of conformance all records showing periods of employment, name of employer where welder, or welding operator, was last employed, and the process for which qualified.

d. A tacker who passes the qualification test is considered eligible to perform tack welding indefinitely in the positions and with the processes for which he/she is qualified, unless there is some specific reason to question the tacker's ability or there has been a gap greater than 6 months since he/she last used the process. In such a case, the tacker is required to pass the prescribed tack welding test.

1.3.5 Inspector Qualification

Submit certificates indicating that certified welding inspectors meet the requirements of AWS QC1. Submit qualifications for nondestructive testing personnel in accordance with the requirements of ANSI/ASNT CP-189 for Levels I or II in the applicable nondestructive testing method. Level I inspectors must have direct supervision of a Level II inspector.

1.3.6 Symbols and Safety

Use symbols in accordance with AWS A2.4, unless otherwise indicated. Follow safe welding practices and safety precautions during welding in conformance with AWS Z49.1.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Conform the design of welded connections to AISC 360, unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Perform welding as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Do not commence welding until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and the submittals approved by the Contracting Officer. Perform all testing at or near the work site. Maintain records of the test results obtained in welding procedure, welder, welding operator, and tacker performance qualifications.

2.1.1 Pre-erection Conference

Hold a pre-erection conference prior to the start of the field welding, to bring all affected parties together and to gain a naturally clear understanding of the project and the Welding Procedure Specifications (WPS) (submitted for all welding, including welding done using pre-qualified procedures). Mandatory attendance is required by all Contractor's welding production and inspection personnel and appropriate Government personnel. Include as items for discussion: responsibilities of various parties; welding procedures and processes to be followed; welding sequence (both within a joint and joint sequence within the building); inspection requirements and procedures, both visual and nondestructive testing; welding schedule; and other items deemed necessary by the attendees.

2.2 WELDING EQUIPMENT AND MATERIALS

Provide all welding equipment, welding electrodes and rods, welding wire, and fluxes capable of producing satisfactory welds when used by a qualified welder or welding operator. Use 70 KSI welding electrodes. Provide welding equipment and materials that comply with the applicable requirements of AWS D1.1/D1.1M and AWS D1.8/D1.8M. Submit product data on welding electrodes and rods.

PART 3 EXECUTION

3.1 WELDING OPERATIONS

3.1.1 Requirements

Conform workmanship and techniques for welded construction to the requirements of AWS D1.1/D1.1M, AWS D1.8/D1.8M and AISC 360. When AWS D1.1/D1.1M, AWS D1.8/D1.8M and the AISC 360 specification conflict, the requirements of AWS D1.1/D1.1M, AWS D1.8/D1.8M govern.

3.1.2 Identification

Identify all welds in one of the following ways:

a. Submit written records to indicate the location of welds made by each welder, welding operator, or tacker.

b. Identify all work performed by each welder, welding operator, or tacker with an assigned number, letter, or symbol to identify welds made by that individual. The Contracting Officer may require welders, welding operators, and tackers to apply their symbol next to the weld by means of rubber stamp, felt-tipped marker with waterproof ink, or other methods that do not cause an indentation in the metal. Place the identification mark for seam welds adjacent to the weld at 3 foot intervals. Identification with die stamps or electric etchers is not allowed.

3.2 QUALITY CONTROL

Perform testing using an approved inspection or testing laboratory or technical consultant; or if approved, the Contractor's inspection and testing personnel may be used instead of the commercial inspection or testing laboratory or technical consultant. A Certified Welding Inspector must perform visual inspection on 100 percent of all welds. Document this inspection in the Visual Weld Inspection Log. Test 50% of CJP welds using ultrasonic testing per Table 6.2 or 6.3 of AWS D1.1/D1.1M. Randomly test 25 % of all PJP and fillet welds or as indicated by magnetic particle or dye penetrant testing. Verify the welds conform to paragraph STANDARDS OF ACCEPTANCE. Conform procedures and techniques for inspection with applicable requirements of AWS D1.1/D1.1M, AWS D1.8/D1.8M, ASTM E165/E165M, and ASTM E709. Submit a Welding Quality Assurance Plan and records of tests and inspections.

3.3 STANDARDS OF ACCEPTANCE

Conform dimensional tolerances for welded construction, details of welds, and quality of welds with the applicable requirements of AWS D1.1/D1.1M, AWS D1.8/D1.8M and the contract drawings. Submit all records of

nondestructive testing.

3.3.1 Nondestructive Testing

The welding is subject to inspection and tests in the mill, shop, and field. Inspection and tests in the mill or shop do not relieve the Contractor of the responsibility to furnish weldments of satisfactory quality. When materials or workmanship do not conform to the specification requirements, the Government reserves the right to reject material or workmanship or both at any time before final acceptance of the structure containing the weldment. Any indication of a defect is regarded as a defect, unless re-evaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present. Submit all records of nondestructive testing in accordance with paragraph STANDARDS OF ACCEPTANCE.

3.3.2 Destructive Tests

Make all repairs when metallographic specimens are removed from any part of a structure. Employ only qualified welders or welding operators, and use the proper joints and welding procedures, including peening or heat treatment if required, to develop the full strength of the members and joints cut and to relieve residual stress.

3.4 GOVERNMENT INSPECTION AND TESTING

In addition to the inspection and tests performed by the Contractor for quality control, the Government will perform inspection and testing for acceptance to the extent determined by the Contracting Officer. The work may be performed by the Government's own forces or under a separate contract for inspection and testing. The Government reserves the right to perform supplemental nondestructive and destructive tests to determine compliance with paragraph STANDARDS OF ACCEPTANCE.

3.5 CORRECTIONS AND REPAIRS

If inspection or testing indicates defects in the weld joints, repair defective welds using a qualified welder or welding operator as applicable. Conduct corrections in accordance with the requirements of AWS D1.1/D1.1M, AWS D1.8/D1.8M and the specifications. Repair all defects in accordance with the approved procedures. Repair defects discovered between passes before additional weld material is deposited. Wherever a defect is removed and repair by welding is not required, blend the affected area into the surrounding surface to eliminate sharp notches, crevices, or corners. After a defect is thought to have been removed, and before re-welding, examine the area by suitable methods to ensure that the defect has been eliminated. Repaired welds must meet the inspection requirements for the original welds.

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 207	(2016; R 2017) Certification Standard for Steel Fabrication and Erection, and Manufacturing of Metal Components
AISC 303	(2016) Code of Standard Practice for Steel Buildings and Bridges
AISC 325	(2017) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 341	(2016) Seismic Provisions for Structural Steel Buildings
AISC 360	(2016) Specification for Structural Steel Buildings
AISC 420	(2010) Certification Standard for Shop Application of Complex Protective Coating Systems
AISC DESIGN GUIDE 10	(1997) Erection Bracing of Low-Rise Structural Steel Buildings

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

AWS D1.8/D1.8M	(2016) Structural Welding Code—Seismic Supplement
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M	(2024b) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C827/C827M	(2023) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F436/F436M	(2019) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F844	(2019) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F959/F959M	(2017a; R 2023) Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural

	Fasteners, Inch and Metric Series
ASTM F1136/F1136M	(2011) Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F2329/F2329M	(2015; R 2023) Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
ASTM F2833	(2011; R 2017) Standard Specification for Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2020) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC Paint 20	(2019) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic)
SSPC Paint 29	(2002; E 2004) Zinc Dust Sacrificial Primer, Performance-Based
SSPC SP 3	(2018) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-301-02	(2023) Design of Risk Category V Structures, National Strategic Military Assets

UFC 3-301-02 (2023) Design of Risk Category V Structures, National Strategic Military Assets

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR Part 1926, Subpart R Steel Erection

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Erection and Erection Bracing Drawings; G, DO

SD-02 Shop Drawings

Fabrication Drawings Including Details of Connections; G, DO

SD-03 Product Data

Shop Primer

Welding Electrodes and Rods

Direct Tension Indicator Washers

Non-Shrink Grout

Tension Control Bolts

Recycled Content for Structural Steel

Recycled Content for Structural Steel Tubing

Recycled Content for Steel Pipe

SD-05 Design Data

Shoring and Temporary Bracing;

SD-06 Test Reports

Class B Coating

Bolts, Nuts, and Washers

Weld Inspection Reports

Direct Tension Indicator Washer Inspection Reports

Bolt Testing Reports

SD-07 Certificates

Steel

Bolts, Nuts, and Washers

Galvanizing

AISC Structural Steel Fabricator Quality Certification

AISC Structural Steel Erector Quality Certification

Welding Procedures and Qualifications

Welding Electrodes and Rods

Certified Welding Inspector

NDT Technician

Welding Procedure Specifications (WPS)

Overhead, Top Running Crane Rail Beam

1.3 AISC QUALITY CERTIFICATION

Work must be fabricated by an AISC Certified Structural Steel Fabricator, in accordance with AISC 207, Category BU. Submit AISC Structural Steel Fabricator quality certification.

Work must be erected by an AISC Structural Steel Certified Erector, in accordance with AISC 207, Category CSE. Submit AISC Structural Steel erector quality certification.

1.4 SEISMIC PROVISIONS

Provide the structural steel system in accordance with AISC 341, Chapter J as amended by UFC 3-301-01 UFC 3-301-02.

1.5 QUALITY ASSURANCE

1.5.1 Preconstruction Submittals

1.5.1.1 Erection and Erection Bracing Drawings

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing. The erection drawings must conform to AISC 303. Erection drawings must be reviewed, stamped and sealed by a registered professional engineer.

1.5.2 Fabrication Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 303, AISC 326 and AISC 325. Fabrication drawings must not be reproductions of contract drawings. Sign and seal fabrication drawings by a registered professional engineer. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member

sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Shoring and temporary bracing must be designed and sealed by a registered professional engineer and submitted for record purposes as part of the drawings. Clearly highlight any deviations from the details shown on the contract drawings highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

1.5.3 Certifications

1.5.3.1 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welder or welding operator is more than 6 months old, the welding operator's qualification certificate must be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

Conform to all requirements specified in AWS D1.1/D1.1M and AWS D1.8/D1.8M.

1.5.3.2 Overhead, Top Running Crane Rail Beam

Submit written field survey results for overhead, top running crane rail beam verifying tolerance requirements per CMAA 70.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide the structural steel system, including shop primer , complete and ready for use (the primer must be compatible with the intumescent coatings for fire protection). Provide structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing in accordance with AISC 303, AISC 360, AISC 341, and UFC 3-301-01 except as modified in this contract.

2.2 STEEL

2.2.1 Structural Steel

Wide flange and WT shapes, Angles, Channels and Plates, shall be as specified in the contract drawings. Provide structural steel containing a minimum of 70 percent recycled content. Submit data identifying percentage of recycled content for structural steel.

2.2.2 Structural Steel Tubing

As Specified in the drawings. Provide structural steel tubing containing a minimum of 25 percent recycled content. Submit data identifying percentage of recycled content for structural steel tubing.

2.2.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B, weight class STD (Standard) or as indicated. Provide steel pipe containing a minimum of 50 percent recycled content. Submit data identifying percentage of recycled content for steel

pipe.

2.3 BOLTS, NUTS, AND WASHERS

Submit the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

2.3.1 Common Grade Bolts

2.3.1.1 Bolts

ASTM A307, Grade A, plain finish hot dipped zinc coating. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.3.1.2 Nuts

ASTM A563, Grade A, heavy hex style.

2.3.1.3 Self-Locking Nuts

Provide nuts with a locking pin set in the nut. The locking pin must slide along the bolt threads, and by reversing the direction of the locking pin, the nut can be removed without damaging the nut or bolt. Provide stainless steel locking pins.

2.3.1.4 Washers

ASTM F844.

2.3.2 High-Strength Bolts

High strength bolts and nuts must be shipped together in the same shipping container. Fasteners indicated to be galvanized shall be tested by the supplier to show that the galvanized nut with the supplied lubricant provided may be rotated from the snug tight condition well in excess of the rotation required for pretentioned installation without stripping. The supplier shall supply nuts that have been lubricated and tested with the supplied bolts.

2.3.2.1 Bolts

ASTM F3125/F3125M, Grade A490M A490, Type 1 Heavy Hex Head Style, plain finish hot dipped zinc coating.

2.3.2.2 Nuts

ASTM A563, Grade and Style as specified in the applicable ASTM bolt standard.

2.3.2.3 Direct Tension Indicator Washers

ASTM F959/F959M. Provide ASTM B695, Class 55, Type 1 galvanizing. Submit product data for direct tension indicator washers.

2.3.2.4 Washers

ASTM F436/F436M, plain carbon steel.

2.3.3 Foundation Anchorage

2.3.3.1 Anchor Rods

ASTM F1554 Gr 55,with supplemental required S1 Class 1A.

2.3.3.2 Anchor Nuts

ASTM A563, Grade A, hex style.

2.3.3.3 Anchor Washers

ASTM F844.

2.3.3.4 Anchor Plate Washers

ASTM A36/A36M.

2.4 STRUCTURAL STEEL ACCESSORIES

2.4.1 Welding Electrodes and Rods

AWS D1.1/D1.1M and AWS D1.8/D1.8M. Submit product data for welding electrodes and rods.

2.4.2 Non-Shrink Grout

ASTM C1107/C1107M, with no ASTM C827/C827M shrinkage. Grout must be nonmetallic. Submit product data for non-shrink grout.

2.4.3 Welded Shear Stud Connectors

ASTM A108, Grades 1010 through 1020. AWS D1.1/D1.1M, Table 7.1, Type B.

2.5 GALVANIZING

ASTM F2329/F2329M, ASTM F1136/F1136M, ASTM F2833 or ASTM B695 for threaded parts or ASTM A123/A123M for structural steel members, as applicable, unless specified otherwise galvanize after fabrication where practicable.

2.6 FABRICATION

Fabrication must be in accordance with the applicable provisions of AISC 325. Fabrication and assembly must be done in the shop to the greatest extent possible. Punch, subpunch and ream, or drill bolt holes perpendicular to the surface of the member.

Compression joints depending on contact bearing must have a surface roughness not in excess of 500 micro inch as determined by ASME B46.1, and ends must be square within the tolerances for milled ends specified in ASTM A6/A6M.

Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer.

Do not splice truss top and bottom chords except as approved by the Contracting Officer. Provide chord splices at panel joints at approximately the third point of the span. The center of gravity lines of truss members must intersect at panel points unless otherwise approved by the Contracting Officer. When the center of gravity lines do not intersect at a panel point, make provisions for the stresses due to eccentricity. Camber of trusses must be 1/8 inch in 10 feet unless otherwise indicated.

2.6.1 Markings

Prior to erection, identify members by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections must be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations. Affix embossed tags to hot-dipped galvanized members.

2.6.2 Shop Primer

SSPC Paint 20 or SSPC Paint 29, (zinc rich primer). Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, galvanized surfaces, surfaces to receive sprayed-on fireproofing, or surfaces within 0.5 inch of the toe of the welds prior to welding (except surfaces on which metal decking and shear studs are to be welded). If flash rusting occurs, re-clean the surface prior to application of primer. Apply primer in accordance with endorsement "SPE-P1" of AISC 420 or approved equal NACE or SSPC certification to a minimum dry film thickness of 2.0 mil. Submit shop primer product data.

Prime slip critical surfaces with a Class B coating in accordance with AISC 325. Submit test report for Class B coating.

Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 45 degrees F or over 95 degrees F; or when the primer may be exposed to temperatures below 40 degrees F within 48 hours after application, unless approved otherwise by the Contracting Officer. Repair damaged primed surfaces with an additional coat of primer.

2.6.2.1 Cleaning

SSPC SP 6/NACE No.3, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

2.6.3 Fireproofing Coated Surfaces

Clean and prepare surfaces to receive sprayed-on fireproofing coatings in accordance with the manufacturer's recommendations, and as specified in Section 07 81 00 SPRAY-APPLIED FIREPROOFING.

2.7 DRAINAGE HOLES

Drill adequate drainage holes to eliminate water traps. Hole diameter

must be 1/2 inch and location indicated on the detail drawings. Hole size and locations must not affect the structural integrity.

PART 3 EXECUTION

3.1 ERECTION

a. Erection of structural steel, except as indicated in item b. below, must be in accordance with the applicable provisions of AISC 325, AISC 303 and 29 CFR Part 1926, Subpart R.

b. For low-rise structural steel buildings (60 feet tall or less and a maximum of 2 stories), erect the structure in accordance with AISC DESIGN GUIDE 10.

After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

3.1.1 STORAGE

Store the material out of contact with the ground in such manner and location as to minimize deterioration.

3.2 CONNECTIONS

Except as modified in this section, design connections indicated in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Holes must not be cut or enlarged by burning. Bolts, nuts, and washers must be clean of dirt and rust, and lubricated immediately prior to installation.

3.2.1 Common Grade Bolts

Tighten ASTM A307 bolts to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

3.2.2 High-Strength Bolts

Provide direct tension indicator washers in all ASTM F3125/F3125M, Grade A325 and Grade A490 bolted connections. Bolts must be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, fully tension bolts, progressing from the most rigid part of a connection to the free edges.

Fastener components shall be protected from dirt and moisture in closed containers at the site of the installation. Fastener components that are not incorporated into the work shall be returned to protected storage at the end of the work shift.

3.2.2.1 Installation of Direct Tension Indicator Washers (DTIW)

Where possible, install the DTIW under the bolt head and tighten the nut. If the DTIW is installed adjacent to the turned element, provide a flat washer between the DTIW and nut when the nut is turned for tightening, and between the DTIW and bolt head when the bolt head is turned for tightening. In addition to the LIW, provide flat washers under both the

bolt head and nut when ASTM F3125/F3125M, Grade A490 bolts are used.

3.3 GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors is not permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

3.4 WELDING

Welding must be in accordance with AWS D1.1/D1.1M and AWS D1.8/D1.8M. Grind exposed welds smooth as indicated. Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

Develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Submit for approval all WPS, whether prequalified or qualified by testing.

3.4.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

Remove only from finished areas. Remove backing strips from bottom flange of moment connections, backgouge the root pass to sound weld metal and reinforce with a 5/16 inch fillet weld minimum.

3.5 SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

3.5.1 Field Priming

Field prime steel exposed to the weather, or located in building areas without HVAC for control of relative humidity. After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat must be cleaned and primed with paint of the same quality as that used for the shop coat.

3.6 GALVANIZING REPAIR

Repair damage to galvanized coatings using ASTM A780/A780M zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.7 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing, except that electric power for field tests will be furnished as set forth in Division 1. Notify the Contracting Officer in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of the inspection.

3.7.1 Welds

3.7.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification

inspections. A Certified Welding Inspector must perform visual inspection on 100 percent of all welds. Document this inspection in the Visual Weld Inspection Log. Submit certificates indicating that certified welding inspectors meet the requirements of AWS QC1.

Inspect proper preparation, size, gaging location, and acceptability of all welds; identification marking; operation and current characteristics of welding sets in use.

3.7.1.2 Nondestructive Testing

Nondestructive testing must be in accordance with AWS D1.1/D1.1M and AWS D1.8/D1.8M. Ultrasonic testing must be performed in accordance with Table 6.2 or 6.3 of AWS D1.1/D1.1M. Test locations must be selected by the Contracting Officer. All personnel performing NDT must be certified in accordance with ANSI/ASNT CP-189 in the method of testing being performed. Submit certificates showing compliance with ANSI/ASNT CP-189 for all NDT technicians. If more than 20 percent of welds made by a welder contain defects identified by testing, then all groove welds made by that welder must be tested by ultrasonic testing, and all fillet welds made by that welder must be inspected by magnetic particle testing (MT) or dye penetrant testing (PT) as approved by the Contracting Officer. When groove welds made by an individual welder are required to be tested, magnetic particle or dye penetrant testing may be used only in areas inaccessible to ultrasonic testing. Retest all repaired areas. Submit weld inspection reports.

Testing frequency: Provide the following types and number of tests:

Test Type	Number of Tests
Magnetic Particle or Dye Penetrant	25 percent of PJP and Fillet Welds
Ultrasonic Testing	50 percent of CJP Welds

3.7.2 Direct Tension Indicator Washers

3.7.2.1 Direct Tension Indicator Washer Compression

Test direct tension indicator washers in place to verify that they have been compressed sufficiently to provide the 0.015 inch gap, as required by ASTM F959/F959M. Submit direct tension indicator washer inspection reports.

3.7.3 High-Strength Bolts

3.7.3.1 Testing Bolt, Nut, and Washer Assemblies

Test a minimum of 3 bolt, nut, and washer assemblies from each mill certificate batch in a tension measuring device at the job site prior to the beginning of bolting start-up. Demonstrate that the bolts and nuts, when used together, can develop tension not less than the provisions specified in AISC 360, depending on bolt size and grade. The bolt tension must be developed by tightening the nut. A representative of the manufacturer or supplier must be present to ensure that the fasteners are properly used, and to demonstrate that the fastener assemblies supplied satisfy the specified requirements. Submit bolt testing reports.

3.7.3.2 Inspection

Inspection procedures must be in accordance with AISC 360. Confirm and report to the Contracting Officer that the materials meet the project specification and that they are properly stored. Confirm that the faying surfaces have been properly prepared before the connections are assembled. Observe the specified job site testing and calibration, and confirm that the procedure to be used provides the required tension. Monitor the work to ensure the testing procedures are routinely followed on joints that are specified to be fully tensioned.

3.7.3.3 Testing

The Government has the option to perform nondestructive tests on 10 percent of the installed bolts to verify compliance with pre-load bolt tension requirements. Provide the required access for the Government to perform the tests. The nondestructive testing will be done in-place using an ultrasonic measuring device or any other device capable of determining in-place pre-load bolt tension. The test locations must be selected by the Contracting Officer. If more than 10 percent of the bolts tested contain defects identified by testing, then all bolts used from the batch from which the tested bolts were taken, must be tested at the Contractor's expense. Retest new bolts after installation at the Contractor's expense.

3.7.4 Inspection and Testing of Steel Stud Welding

Perform verification inspection and testing of steel stud welding conforming to the requirements of AWS D1.1/D1.1M, Stud Welding Clause. The Contracting Officer will serve as the verification inspector. Bend test studs that do not show a full 360 degree weld flash or have been repaired by welding as required by AWS D1.1/D1.1M, Stud Welding Clause. Studs that crack under testing in the weld, base metal or shank will be rejected and replaced by the Contractor at no additional cost.

-- End of Section --

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SECTION 05 21 00

STEEL JOIST FRAMING
05/15, CHG 1: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC Paint 15	(1999; E 2004) Steel Joist Shop Primer/Metal Building Primer
SSPC SP 2	(2018) Hand Tool Cleaning

STEEL JOIST INSTITUTE (SJI)

SJI COMPOSITE JOISTS	(2007; Supplement 1 2010) Standard Specifications for Composite Steel Joist Catalog
SJI LOAD TABLES	(2020) Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders - 45th Edition
SJI MANUAL	(2009) 80 Years of Open Web Steel Joist Construction
SJI Technical Digest 5	(2015) Technical Digest 5 Vibration of Steel Joist - Concrete Floors

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction

29 CFR 1926.756	Steel Erection; Beams and Columns
29 CFR 1926.757	Steel Erection; Open Web Steel Joists

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Welder Qualification

SD-02 Shop Drawings

Steel Joist Framing; G, DO

SD-03 Product Data

Recycled Content Of Steel Products;

SD-05 Design Data

Design Calculations; G, DO

SD-06 Test Reports

Erection Inspection; G, RO

Welding Inspections; G, RO

SD-07 Certificates

Certification of Compliance; G, RO

1.3 QUALITY ASSURANCE

Perform all work in compliance with the requirements set forth in 29 CFR 1926.

1.3.1 Drawing Requirements

Submit drawings of steel joist framing including fabrication, specifications for shop painting, and identification markings of joists . Show joist type and size, layout in plan, all applicable loads, deflection criteria, and erection details including methods of anchoring, framing at openings, type, size, and location and connections for and spacing of bridging, requirements for field welding, and details of accessories as applicable.

1.3.2 Certification of Compliance

Prior to construction commencement, submit certification for welder qualification, in compliance with AWS D1.1/D1.1M, welding operation, and tacker, stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual

certifying the qualification tests. Submit certification of compliance for the following:

a. SJI MANUAL

b. Steel Joist Institute Member Fabricator

c. 29 CFR 1926

d. 29 CFR 1926.757

e. Statement from steel joist manufacturer, that work was performed in accordance with approved construction documents and with SJI standard specifications, in accordance with ICC IBC Section 1704.2.5.2.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, transport, and store joists in a manner to prevent damage affecting their structural integrity. Verify piece count of all joist products upon delivery and inspect all joists products for damage. Report any damage to the joist supplier. Store all items off the ground in a well drained location protected from the weather and easily accessible for inspection and handling. Store joists with top chord down and with joists in a vertical position. Store deep joists horizontally if they were shipped on their sides.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Designate steel joists on the drawings in accordance with the standard designations of the Steel Joist Institute. Joists of other standard designations or joists with properties other than those shown may be substituted for the joists designated provided the structural properties are equal to or greater than those of the joists shown and provided all other specified requirements are met.

2.2 STEEL JOISTS

Provide steel joists conforming to SJI LOAD TABLES. Design joists designated K, KCS, LH and DLH to support the loads given in the applicable standard load tables of SJI LOAD TABLES. Submit design calculations for composite steel joists, net uplift loads, non-SJI standard details, and field splices. Include cover letter signed and sealed by the joist manufacturer's registered design professional.

Applicable mezzanine joist framing shall be designed for the vibration from the supply fans in accordance with SJI Technical Digest 5. Include any applicable analysis and calculations for the supply fan vibration in the submitted design calculations.

2.2.1 Steel Joist Camber

Camber joists according to SJI LOAD TABLES.

2.2.2 Special Steel Joists

Provide special joists and connections capable of withstanding the design loads indicated with a live-load deflection less than L/240 for roof

joists and L/360 for floor joists.

2.2.3 Steel Joist Substitutes and Outriggers

Provide joist substitutes and outriggers conforming to SJI LOAD TABLES with steel angle or channel members.

2.2.4 Composite Steel Joists

Provide composite steel joists conforming to SJI COMPOSITE JOISTS.

2.2.5 Joist Girders

Provide joist girders capable of withstanding the design loads indicated with a live-load deflection less than L/240 for roof girders and L/360 for floor girders.

Camber joist girders according to SJI LOAD TABLES.

2.3 RECYCLED CONTENT

Provide products with an average recycled content of steel products of postconsumer recycled content plus one half of preconsumer recycled content not less than 25 percent.

2.4 ACCESSORIES AND FITTINGS

2.4.1 Bridging

Provide bridging of material, size, and type required by SJI LOAD TABLES for type of joist, chord size, spacing and span. Furnish additional erection bridging if required for stability.

2.4.2 Bearing Plates

Fabricate steel bearing plats from ASTM A36/A36M steel of size and thickness indicated.

2.4.3 Ceiling Extensions

Furnish ceiling extensions, either bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch of finished wall surface unless otherwise indicated.

2.5 SHOP PAINTING

SSPC Paint 15. Shop prime joists, except as modified herein, in accordance with SSPC PA 1. Clean joists in accordance with SSPC SP 2 before priming.The primer must be compatible with the intumescent coatings for fire protection. If flash rusting occurs, re-clean the surface prior to application of primer. For joists and joist girders which require finish painting under Section 09 90 00 PAINTS AND COATINGS, the primer paint must be compatible with the finish paint.

PART 3 EXECUTION

3.1 ERECTION

Install joists in conformance with SJI LOAD TABLES for the joist series indicated, and the requirements of 29 CFR 1926 and 29 CFR 1926.757 and 29 CFR 1926.756. Handle and set joists avoiding damage to the members. Place the "tag end" of joists as shown on the joists placement plans. Ensure that square-end joists are erected right side up. Place joists on joist girders in accordance with the joist placement plan, noting that in many instances joist may not need to be placed at a joist girder panel point. Distribute temporary loads so that joist capacity is not exceeded. Remove damaged joists from the site, except when field repair is approved and such repairs are satisfactorily made in accordance with the manufacturer's recommendations. Do not repair, field modify, or alter any joists without specific written instructions from the Designer of Record and/or joist manufacturer.

Install and connect bridging concurrently with joist erection, before construction loads are applied. Do not apply loads to bridging. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams. Do not cut away vertical leg of bridging where bridging makes an elevation transition; weld a separate piece of bridging at the transition. Perform all welding in accordance with AWS D1.1/D1.1M.

3.2 BEARING PLATES

Provide bearing plates to accept full bearing after the supporting members have been plumbed and properly positioned, but prior to placing superimposed loads. The area under the plate must be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Provide bedding mortar and grout as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3 PAINTING

3.3.1 Touch-Up Painting

After erection of joists , touch-up connections and areas of abraded shop coat with paint of the same type used for the shop coat.

3.4 VISUAL INSPECTIONS

Perform the following visual inspections:

a. Verify that all joists are spaced properly.

b. Verify that there is sufficient joist bearing on steel beams, concrete, and masonry.

c. Verify all bridging lines are properly spaced and anchored.

d. Verify that damage has not occurred to the joists during erection.

e. Verify the joists are aligned vertically and there is no lateral sweep in the joists.

f. Where concentrated loads are present on the joists verify that they are located in accordance with the joists placement plan.

g. Verify welding of bridging and joist seats in accordance with AWS D1.1/D1.1M, Section 6. Perform erection inspection and field welding inspections with AWS certified welding inspectors.

h. Verify proper bolting of diagonal bridging and joist seats where the bolts are snug-tight.

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STEEL DECKS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI D100	(2017) Cold-Formed Steel Design Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM D746	(2014) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1149	(2018) Standard Test Method for Rubber Deterioration - Cracking in an Ozone Controlled Environment
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/
FM DS 1-28R	(1998) Data Sheet: Roof Systems

STEEL DECK INSTITUTE (SDI)

ANSI/SDI C	(2017) Standard for Composite Steel Floor Deck - Slabs
ANSI/SDI NC	(2017) Standard for Non-Composite Steel Floor Deck
ANSI/SDI QA/QC	(2017) Standard for Quality Control and Quality Assurance for Installation of Steel Deck
SDI DDM04	(2015; Errata 1-3 2016; Add 1 2015; Add 2 20162006) Diaphragm Design Manual; 4th Edition
SDI DDP	(1987; R 2000) Deck Damage and Penetrations
SDI MOC3	(2016) Manual of Construction with Steel Deck (3rd Edition)

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction

UL SOLUTIONS (UL)

UL 580	(2006; Reprint Mar 2019) UL Standard for Safety Tests for Uplift Resistance of Roof Assemblies
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, DO

SD-03 Product Data

Accessories

Deck Units

Galvanizing Repair Paint

Touch-Up Paint

Welding Equipment

Welding Rods and Accessories

Recycled Content of Steel Products

SD-04 Samples

Metal Roof Deck Units

Flexible Closure Strips

SD-05 Design Data

Deck Units; G, DO

SD-07 Certificates

Powder-Actuated Tool Operator

Welder Qualifications

Welding Procedures

Fire Safety

Wind Storm Resistance

Manufacturer's Certificate

Stud Manufacture's Certification

Stud Manufacture's Test Reports

1.3 QUALITY ASSURANCE

1.3.1 Deck Units

Furnish deck units and accessory products from a manufacturer regularly engaged in manufacture of steel decking. Provide manufacturer's certificates attesting that the decking material meets the specified requirements.

1.3.2 Certification of Powder-Actuated Tool Operator

Provide manufacturer's certificate attesting that the operators are authorized to use the low velocity powder-actuated tool.

1.3.3 Qualifications for Welding Work

Follow Welding Procedures of AWS D1.3/D1.3M for sheet steel and AWS D1.1/D1.1M for stud welding.
Submit qualified Welder Qualifications in accordance with AWS D1.3/D1.3M for sheet steel and AWS D1.1/D1.1M for stud welding, or under an equivalent approved qualification test. Perform tests on test pieces in positions and with clearances equivalent to those actually encountered. Test specimens shall be made in the presence of Contracting Officer and shall be tested by an approved testing laboratory at the Contractor's expense. If a test weld fails to meet requirements, perform an immediate retest of two test welds until each test weld passes. Failure in the immediate retest will require the welder be retested after further practice or training, performing a complete set of test welds.

Submit manufacturer's catalog data for Welding Equipment and Welding Rods and Accessories.

1.3.4 Regulatory Requirements

1.3.4.1 Fire Safety

Test roof deck as a part of a roof deck construction assembly of the type used for this project, listing as fire classified in the UL Fire Resistance, or listing as Class I construction in the FM APP GUIDE, and so labeled.

1.3.4.2 Wind Storm Resistance

Provide roof construction assembly capable of withstanding a nominal uplift pressure of 90 pounds per square foot when tested in accordance with the uplift pressure test described in the FM DS 1-28R or as described in UL 580 and in general compliance with UFC 3-301-01.

1.3.5 Fabrication Drawings

Show type and location of units, location and sequence of connections, bearing on supports, methods of anchoring, attachment of accessories, adjusting plate details, cant strips, ridge and valley plates, metal closure strips, size and location of holes to be cut and reinforcement to

be provided, the manufacturer's erection instructions and other pertinent details.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver deck units to the site in a dry and undamaged condition. Store and handle steel deck in a manner to protect it from corrosion, deformation, and other types of damage. Do not use decking for storage or as working platform until units have been fastened into position. Exercise care not to damage material or overload decking during construction. The maximum uniform distributed storage load must not exceed the design live load. Stack decking on platforms or pallets and cover with weathertight ventilated covering. Elevate one end during storage to provide drainage. Maintain deck finish at all times to prevent formation of rust. Repair deck finish using touch-up paint. Replace damaged material.

1.5 DESIGN REQUIREMENTS FOR ROOF DECKS

1.5.1 Properties of Sections

Properties of metal roof deck sections must comply with engineering design width as limited by the provisions of AISI D100 and listed in the drawings.

1.5.2 Allowable Loads

Indicate total uniform dead and live load for detailing purposes.

PART 2 PRODUCTS

2.1 DECK UNITS

Submit manufacturer's design calculations, or applicable published literature for the structural properties of the proposed deck units.

Provide products with an average recycled content of steel products so postconsumer recycled content plus one half of preconsumer recycled content not less than 25 percent.

2.1.1 Roof Deck

Conform to ASTM A792/A792M or ASTM A1008/A1008M for deck used in conjunction with insulation and built-up roofing. Fabricate roof deck units of the steel design thickness required by the design drawings and shop prime, the primer must be compatible with the intumescent coatings for fire protection . Furnish sample of Metal Roof Deck Units used to illustrate actual cross section dimensions and configurations.

2.1.2 Composite Deck

Conform to ASTM A653/A653M or ASTM A1008/A1008M for composite deck assembly. Fabricate deck used as the tension reinforcing in composite deck of The steel design thickness required by the design drawings.

2.1.3 Length of Deck Units

Provide deck units of sufficient length to span three or more spacings where possible.

2.1.4 Shop Priming

Shop prime accessories and underside of deck at the factory after coating. Clean surfaces in accordance with the manufacturer's standard procedure followed by a spray, dip or roller coat of rust-inhibitive primer, oven cured.

2.1.5 Touch-Up Paint

Provide a high zinc-dust content paint for regalvanizing welds in galvanized steel conforming to ASTM A780/A780M.

Provide touch-up paint for shop-painted units of the same type used for the shop painting , Maintain finish of deck units and accessories by using touch-up paint whenever necessary to prevent the formation of rust.

2.2 ACCESSORIES

Provide accessories of same material as deck, unless specified otherwise. Provide manufacturer's standard type accessories, as specified.

2.2.1 Adjusting Plates

Provide adjusting plates, or segments of deck units, of same thickness and configuration as deck units in locations too narrow to accommodate full size units. Provide factory cut plates of predetermined size where possible.

2.2.2 End Closures

Fabricated of sheet metal by the deck manufacturer. Provide end closures minimum 0.0598 inch thick to close open ends at exposed edges of floors, end walls, eaves, and openings through deck.

2.2.3 Partition Closures

Provide closures for closing voids above interior walls and partitions that are perpendicular to the direction of the configurations. Provide sheet steel closures above fire-resistant interior walls and partitions located on both sides of wall or partition.

2.2.4 Flexible Closure Strips for Roof Decks

Provide strips made of vulcanized, closed-cell, synthetic rubber material specified and premolded to the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking.

Conforming to ASTM D1056, Grade 2A1, with the following additional properties:

Brittleness temperature of minus 40 degrees F when tested in accordance with ASTM D746.

Flammability resistance with a flame spread rating of less than 25 when tested in accordance with ASTM E84.

Resistance to ozone must be "no cracks" after exposure of a sample kept under a surface tensile strain of 25 percent to an ozone concentration of 100 parts per million of air by volume in air for 100

hours at 104 degrees F and tested in accordance with ASTM D1149.

Provide a elastomeric type adhesive as recommended by the manufacturer of the flexible closure strips.

2.2.5 Closure Plates for Composite Deck

Support and retain concrete at each floor level. Provide edge closures at all edges of the slab of sufficient strength and stiffness to support the wet concrete. Provide metal closures for all openings in composite steel deck 1/4 inch and over.

2.2.6 Sheet Metal Collar

Where deck is cut for passage of pipes, ducts, columns, etc., and deck is to remain exposed, provide a neatly cut sheet metal collar to cover edges of deck. Do not cut deck until after installation of supplemental supports.

2.2.7 Cover Plates

Sheet metal to close panel edge and end conditions, and where panels change direction or butt. Polyethylene-coated, self-adhesive, 2 inch wide joint tape may be provided in lieu of cover plates on flat-surfaced decking butt joints.

Fabricate cover plates for abutting floor deck units from the specified structural-quality steel sheets not less than nominal 18 gagethick before galvanizing. Provide 6 inch wide cover plates and form to match the contour of the floor deck units.

2.2.8 Roof Sump Pans

Sump pans must be provided for roof drains and must be minimum 0.075 inch thick steel, flat type. Shape sump pans to meet roof slope by the supplier or by a sheet metal specialist. Provide bearing flanges of sump pans to overlap steel deck a minimum of 3 inch. Shape, size, and reinforce the opening in bottom of the sump pan to receive roof drain.

2.2.9 Column Closures

Sheet metal, minimum 0.0598 inch thick or metal rib lath.

2.2.10 Access Hole Covers

Sheet metal, minimum 0.0598 inch thick.

2.2.11 Hanger

Provide clips or loops for utility systems of one or more of the following types:

a. Lip tabs or integral tabs where noncellular decking or flat plate of cellular section is 0.0598 inch thick or more, and a structural concrete fill is used over deck.

b. Slots or holes punched in decking for installation of pigtails.

c. Tabs driven from top side of decking and arranged so as not to pierce

electrical cells.

d. Decking manufacturer's standard as approved by the Contracting Officer.

2.2.12 Shear Connectors

Provide shear connectors in accordance with AWS D1.1/D1.1M headed stud Type B. Submit stud manufacture's certification that the studs delivered conform to the material requirements. Submit stud manufacture's test reports for the last completed in-plant quality control mechanical tests.

2.2.13 Cant Strips for Roof Decks

Fabricate cant strips from the specified commercial-quality steel sheets not less than nominal 0.0598 inch thick before galvanizing. Bend strips to form a 45-degree cant not less than 5 inch wide, with top and bottom flanges a minimum 3 inch wide. Length of strips 10 feet.

2.2.14 Ridge and Valley Plates for Roof Decks

Fabricate plates from the specified structural-quality steel sheets, not less than nominal 0.0598 inch thick before galvanizing. Provide plates of minimum 4-1/2 inch wide and bent to provide tight fitting closures at ridges and valleys. Provide a minimum length of ridge and valley plates of 10 feet.

2.2.15 Metal Closure Strips for Roof Decks

Fabricate strips from the specified commercial-quality steel sheets not less than nominal 0.0598 inch thick before galvanizing. Provide strips from the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking.

2.2.16 Galvanized Steel Angles for Roof Decks

Provide hot-rolled carbon steel angles conforming to ASTM A36/A36M, and hot-dip galvanized in accordance with ASTM A123/A123M.

2.2.17 Miscellaneous Accessories

Furnish the manufacturer's standard accessories to complete the deck installation. Furnish metal accessories of the same material as the deck and with the minimum design thickness as follows: saddles, 0.0474 inch welding washers, 0.0598 inch other metal accessories, 0.0358 inch unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

Prior to installation of decking units and accessories, examine worksite to verify that as-built structure will permit installation of decking system without modification.

3.2 INSTALLATION

Install steel deck units in accordance with 29 CFR 1926, Subpart R – Steel Erection, ANSI/SDI QA/QC, and approved shop drawings. Place units on structural supports, properly adjusted, leveled, and aligned at right angles to supports before permanently securing in place. Damaged deck and

accessories including material which is permanently stained or contaminated, deformed, or with burned holes shall not be installed. Extend deck units over three or more supports unless absolutely impractical. Report inaccuracies in alignment or leveling to the Contracting Officer and make necessary corrections before permanently anchoring deck units. Locate deck ends over supports only. Lap 2 inch deck ends. Do not use unanchored deck units as a work or storage platform. Do not fill unanchored deck with concrete. Permanently anchor units placed by the end of each working day. Do not support suspended ceilings, light fixtures, ducts, utilities, or other loads by steel deck unless indicated. Distribute loads by appropriate means to prevent damage. Prepare shoring in position before concrete placement begins in composite or form deck.

3.2.1 Attachment

Immediately after placement and alignment, and after correcting inaccuracies, permanently fasten steel deck units to structural supports and to adjacent deck units by welding with normal 5/8 inchdiameter puddle welds, fastened with screws, powder-actuated fasteners, or pneumatically driven fasteners as indicated on the design drawings and in accordance with manufacturer's recommended procedure. Clamp or weight deck units to provide firm contact between deck units and structural supports while performing welding or fastening. Attachment of adjacent deck units by button-punching is prohibited.

3.2.1.1 Welding

Perform welding in accordance with AWS D1.3/D1.3M using methods and electrodes recommended by the manufacturers of the base metal alloys being used. Ensure only operators previously qualified by tests prescribed in AWS D1.3/D1.3M make welds. Immediately recertify, or replace qualified welders, that are producing unsatisfactory welding. Conform to the recommendations of the Steel Deck Institute and the steel deck manufacturer for location, size, and spacing of fastening. Do use welding washers at the connections of the deck to supports. Do not use welding washers at sidelaps. Holes and similar defects will not be acceptable. Attach all partial or segments of deck units to structural supports in accordance with Section 2.5 of SDI DDM04. Attach shear connectors as shown and welded as per AWS D1.1/D1.1M through the steel deck to the steel member . Immediately clean welds by chipping and wire brushing. Heavily coat welds, cut edges and damaged portions of shop primed finish with the manufacturer's standard touch-up paint.

3.2.1.2 Sidelap Fastening

Lock sidelaps between adjacent floor deck units together by welding or screws as indicated.

3.2.2 Openings

Cut or drill all holes and openings required and be coordinated with the drawings, specifications, and other trades. Frame and reinforce openings through the deck in conformance with SDI DDP. Reinforce holes and openings 6 to 12 inch across by 0.0474 inch thick steel sheet at least 12 inch wider and longer than the opening and be fastened to the steel deck at each corner of the sheet and at a maximum of 6 inch on center. Reinforce holes and openings larger than 12 inch by steel channels or angles installed perpendicular to the steel joists and supported by the adjacent

steel joists. Install steel channels or angles perpendicular to the deck ribs and fasten to the channels or angles perpendicular to the steel joists.

3.2.3 Deck Damage

SDI MOC3, for repair of deck damage.

3.2.4 Touch-Up Paint

3.2.4.1 Roof Deck

After roof decking installation, wire brush, clean, and touchup paint the scarred areas on top and bottom surfaces of metal roof decking. The scarred areas include welds, weld scars, bruises, and rust spots. Touchup galvanized surfaces with galvanizing repair paint. Touchup painted surfaces with repair paint of painted surfaces.

3.2.4.2 Floor Deck

For floor decking installation, wire brush, clean, and touchup paint the scarred areas on the top and bottom surfaces of the metal floor decking and on the surface of supporting steel members. Include welds, weld scars, bruises, and rust spots for scarred areas. Touched up the galvanized surfaces with galvanizing repair paint. Touch up the painted surfaces with paint for the repair of painted surfaces.

3.2.5 Accessory Installation

3.2.5.1 Adjusting Plates

Provide in locations too narrow to accommodate full-size deck units and install as shown on shop drawings.

3.2.5.2 End Closures

Provide end closure to close open ends of cells at columns, walls, and openings in deck.

3.2.5.3 Closures Above Partitions

Provide for closing voids between cells over partitions that are perpendicular to direction of cells. Provide a one-piece closure strip for partitions 4 inch nominal or less in thickness and two-piece closure strips for wider partitions. Provide sheet metal closures above fire-rated partitions at both sides of partition with space between filled with fiberglass insulation.

3.2.5.4 Cover Plates

Where concrete leakage would be a problem, provide metal cover plates, or joint tape, at joints between decking sheets, cellular or noncellular, to be covered with concrete fill.

3.2.5.5 Column Closures

Provide for spaces between floor decking and columns which penetrate the deck. Field cut closure plate to fit column in the field and tack weld to decking and columns.

3.2.5.6 Access Hole Covers

Provide access hole covers to seal holes cut in decking to facilitate welding of the deck to structural supports.

3.2.5.7 Hangers

Provide as indicated to support utility system . Space devices so as to provide one device per 6.25 square feet.

Concrete Work NOTE: Ensure that admixtures containing chloride salts are not used in concrete placed on steel deck. Coordinate with Section 03 30 00 CAST-IN-PLACE CONCRETE. Prior to placement of concrete, inspect installed decking to ensure that there has been no permanent deflection or other damage to decking. Replace decking which has been damaged or permanently deflected as approved by the Contracting Officer. Place concrete on metal deck in accordance with Construction Practice of ANSI/SDI C or ANSI/SDI NC.
3.2.6 Concrete Work

Prior to placement of concrete, inspect installed decking to ensure that there has been no permanent deflection or other damage to decking. Replace decking which has been damaged or permanently deflected as approved by the Contracting Officer. Place concrete on metal deck in accordance with Construction Practice of ANSI/SDI C or ANSI/SDI NC.

3.2.7 Preparation of Fire-Proofed Surfaces

Provide deck surfaces, both composite and noncomposite, which are to receive sprayed-on fireproofing, galvanized and free of all grease, mill oil, paraffin, dirt, salt, and other contaminants which impair adhesion of the fireproofing. Complete any required cleaning prior to steel deck installation using a cleaning method that is compatible with the sprayed-on fireproofing.

3.3 CANT STRIPS FOR ROOF DECKS

Provide strips to be fusion welded to surface of roof decking, secured to wood nailers by galvanized screws or to steel framing by galvanized self-tapping screws or welds. Do not exceed spacing of welds and fasteners of 12 inch. Lap end joints a minimum 3 inch and secure with galvanized sheet metal screws spaced a maximum 4 inch on center.

3.4 RIDGE AND VALLEY PLATES FOR ROOF DECKS

Provide plates to be fusion welded to top surface of roof decking. Lap end joints a minimum 3 inch. For valley plates, provide endlaps to be in the direction of water flow.

3.5 CLOSURE STRIPS FOR ROOF DECKS

Provide closure strips at open, uncovered ends and edges of the roof decking and in voids between roof decking and top of walls and partitions where indicated. Install closure strips in position in a manner to provide a weathertight installation.

3.6 ROOF INSULATION SUPPORT FOR ROOF DECKS

Provide metal closure strips for support of roof insulation where rib

openings in top surface of metal roof decking occur adjacent to edges and openings. Weld metal closure strips in position.

3.7 CLEANING AND PROTECTION FOR ROOF DECKS

Upon completion of the deck, sweep surfaces clean and prepare for installation of the roofing.

3.8 FIELD QUALITY CONTROL

3.8.1 Headed Stud Inspection

In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.

b. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.8.2 Deck Weld Inspection

Visual inspect welds in accordance with AWS D1.3/D1.3M.

-- End of Section --

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05/15, CHG 1: 08/18

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SECTION 05 40 00

COLD-FORMED METAL FRAMING
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318	(2019; R 2022) Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary (ACI 318R-19)

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI S100	(2012) North American Specification for the Design of Cold-Formed Steel Structural Members
AISI S110	(2007; Suppl 1; Reaffirmed 2012) Standard for Seismic Design of Cold-Formed Steel Structural Systems - Special Bolted Moment Frames
AISI S200	(2007) North American Standard for Cold-Formed Steel Framing - General Provision
AISI S201	(2007) North American Standard for Cold-Formed Steel Framing - Product Data
AISI S202	(2011) Code of Standard Practice for Cold-formed Steel Structural Framing
AISI S211	(2007) North American Standard for Cold-Formed Steel Framing - Wall Stud Design
AISI S212	(2007) North American Standard for Cold-Formed Steel Framing - Header Design
AISI S213	(2007; Suppl 1 2009) North American Standard for Cold-Formed Steel Framing - Lateral Design
AISI S214	(2012) North American Standard for Cold-Formed Steel Framing – Truss Design

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding

	Code - Steel
AWS D1.3/D1.3M	(2018) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A370	(2024) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1003/A1003M	(2023; E 2024) Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members
ASTM C955	(2017) Standard Specification for Cold-Formed Steel Structural Framing Members
ASTM C1007	(2020) Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories
ASTM C1513	(2018) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
ASTM E119	(2022) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E329	(2023) Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield

	Strength
ASTM F1941	(2010) Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Unified Inch Screw Threads (UN/UNR))
ASTM F2329/F2329M	(2015; R 2023) Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Framing Components; G, DO

SD-03 Product Data

Steel Studs, Joists, Tracks, Bracing, Bridging and Accessories

Recycled Content of Steel Products; G, RO

SD-05 Design Data

Metal Framing Calculations; G, DO

SD-07 Certificates

Load-Bearing Cold-Formed Metal Framing

Welds

1.3 DELIVERY, STORAGE, AND HANDLING

Steel framing and related accessories shall be stored and handled in accordance with the AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

1.4 LOAD-BEARING COLD-FORMED METAL FRAMING

Include top and bottom tracks, bracing, fastenings, and other accessories necessary for complete installation. Framing members shall have the structural properties indicated. Where physical structural properties are not indicated, they shall be as necessary to withstand all imposed loads as indicated in the drawings. Design framing in accordance with AISI S100.

Non-load-bearing metal framing, furring, and ceiling suspension systems are specified in Section 09 22 00 SUPPORTS FOR PLASTER AND GYPSUM BOARD. Metal suspension systems for acoustical ceilings are specified in Section 09 51 00 ACOUSTICAL CEILINGS.

Submit mill certificates or test reports from independent testing agency, qualified in accordance with ASTM E329, showing that the steel sheet used in the manufacture of each cold-formed component complies with the minimum yield strengths and uncoated steel thickness specified. Test reports shall be based on the results of three coupon tests in accordance with ASTM A370.

1.5 MAXIMUM DEFLECTION

Deflections of structural members shall not exceed the more restrictive of the limitations of ICC IBC and UFC 3-301-01.

1.6 QUALITY ASSURANCE

a. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a registered professional engineer.

b. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 for testing indicated.

c. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

d. Welding Qualifications: Qualify procedures and personnel according to the following:

(1) AWS D1.1/D1.1M, "Structural Welding Code - Steel".

(2) AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel".

e. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E119 by, and displaying a classification label from, a testing and inspecting agency acceptable to authorities having jurisdiction.

f. AISI Specifications and Standards: Comply with:

(1) AISI S100, "North American Specification for the Design of Cold-Formed Steel Structural Members".

(2) AISI S110, "Standard for Seismic Design of Cold-Formed Steel

Structural Systems - Special Bolted Moment Frames".

(3) AISI S200, "North American Standard for Cold-Formed Steel Framing - General Provision".

(4) AISI S201, "North American Standard for Cold-Formed Steel Framing - Product Data".

(5) AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

(6) AISI S211, "North American Standard for Cold-Formed Steel Framing - Wall Stud Design".

(7) AISI S212, "North American Standard for Cold-Formed Steel Framing - Header Design".

(8) AISI S213, "North American Standard for Cold-Formed Steel Framing - Lateral Design".

(9) AISI S214, "North American Standard for Cold-Formed Steel Framing - Truss Design".

1.6.1 Drawing Requirements

Submit framing components to show sizes, thicknesses, layout, material designations, methods of installation, and accessories including the following:

a. Cross sections, plans, and/or elevations showing component types and locations for each framing application; including shop coatings and material thicknesses for each framing component.

b. Connection details showing fastener type, quantity, location, and other information to assure proper installation.

c. Drawings depicting panel configuration, dimensions, components, locations, and construction sequence if the Contractor elects to install prefabricated/prefinished frames.

Sign and seal fabrication drawings by a registered professional engineer.

1.6.2 Design Data Required

Submit metal framing calculations with design criteria and structural loading to verify sizes, thickness, and spacing of members and connections signed and sealed by a registered professional engineer. Show methods and practices used in installation.

PART 2 PRODUCTS

2.1 STEEL STUDS, JOISTS, TRACKS, BRACING, BRIDGING AND ACCESSORIES

Framing components shall comply with ASTM C955 and the following.

a. Provide products with an average recycled content of steel products so postconsumer recycled content plus one half of preconsumer recycled content not less than 25 percent.

b. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

(1) Grade: As required by structural performance.

(2) Coating: G60 (Z180), A60 (ZF180), AZ50 (AZ150), or GF30 (ZGF90).

c. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

(1) Minimum Base-Metal Thickness: 0.0329 inch.

(2) Flange Width: 1-5/8 inches.

d. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

(1) Minimum Base-Metal Thickness: 0.0329 inch.

(2) Flange Width: 1-1/4 inches.

e. Roof Truss Members: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:

(1) Minimum Base-Metal Thickness: 0.0329 inch.

(2) Flange Width: 1-5/8 inches , minimum at top and bottom chords connecting to sheathing or directly fastened construction.

f. Floor Truss Members: Manufacturer's standard C-shaped steel sections, of web depths indicated, unpunched, with stiffened flanges, and as follows:

(1) Minimum Base-Metal Thickness: 0.0329 inch.

(2) Flange Width: 1-5/8 inches , minimum at top and bottom chords connecting to sheathing or directly fastened construction.

2.1.1 Studs and Joists of 54 mils (0.054 Inch) and Heavier

Galvanized steel, ASTM A653/A653M and ASTM A1003/A1003M, SS Grade 50, G60 .

2.1.2 Studs and Joists of 43 mils (0.043 Inch) and Lighter

Studs and Joists of 43 mils (0.043 Inch) and Lighter, Track, and Accessories (All thicknesses): Galvanized steel, ASTM A653/A653M and ASTM A1003/A1003M, SS, Grade 33 33,000 psi G60.

2.1.3 Sizes, Thickness, Section Modulus, and Other Structural Properties

Size and thickness as required.

2.2 MARKINGS

Studs and track shall have product markings stamped on the web of the section. The markings shall be repeated throughout the length of the member at a maximum spacing of 4 feet on center and shall be legible and easily read. The product marking shall include the following:

a. An ICC number.

b. Manufacturer's identification.

c. Minimum delivered uncoated steel thickness.

d. Protective coating designator.

e. Minimum yield strength.

2.3 CONNECTIONS

2.3.1 Steel-To-Concrete Connections

a. Anchor Rods: ASTM F1554, Grade 55; galvanized per ASTM A153/A153M.

b. Post-Installed Concrete Anchors: Adhesive or expansion anchors fabricated from corrosion-resistant materials with allowable load capacities in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.

c. Power-Actuated Fasteners: Fabricated from corrosion-resistant materials with allowable load capacities in accordance with ICC-ES AC 70 greater than or equal to the design load as determined by testing per ASTM E1190 conducted by a qualified testing agency.

2.3.2 Steel-To-Steel Connections

a. Screws: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping steel screws of the type and size indicated. Provide low-profile head beneath sheathing and manufacturer's standard elsewhere. Electroplated to a minimum of 5 micron zinc coating per ASTM F1941 or hot-dipped galvanized per ASTM A123/A123M or ASTM A153/A153M.

b. Bolts: ASTM A307 coated by hot-dip process per ASTM F2329/F2329M or zinc-coated by mechanical-deposition process per ASTM B695, Class 55.

c. Welding Electrodes: Comply with AWS standards.

2.4 PLASTIC GROMMETS

Supply plastic grommets for stud webs as recommended by stud manufacturer, to protect electrical wires and plumbing piping. Prevent metal-to-metal contact between wiring/piping and studs.

2.5 SEALER GASKET

Closed-cell neoprene foam, 1/4-inch thick, selected from manufacturer's standard widths to match width of bottom track on concrete slab or foundation.

PART 3 EXECUTION

3.1 TRUSS FABRICATION

a. Fabricate cold-formed steel trusses and accessories plumb, square, and

true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

b. Truss must be fabricated either on site or off site prior to erection.

c. Fabricate trusses using jigs or templates.

d. Splices can only occur at joints.

e. Cut truss members by sawing or shearing: do not torch cut.

f. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.

g. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

h. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses to prevent damage or permanent distortion.

3.2 FASTENING

Fasten framing members together by welding or by using self-drilling, self-tapping screws. Electrodes and screw connections shall be as required and indicated in the design calculations.

3.2.1 Welds

All welding shall be performed in accordance with AWS D1.3/D1.3M, as modified by AISI S100. All welders, welding operations, and welding procedures shall be qualified according to AWS D1.3/D1.3M. Submit certified copies of welder qualifications test records showing qualification in accordance with AWS D1.3/D1.3M. All welds shall be cleaned and coated with rust inhibitive galvanizing paint. Do not field weld materials lighter than 43 mils.

3.2.2 Screws

Screws shall be of the self-drilling self-tapping type, size, and location as required. Screw penetration through joined materials shall not be less than three exposed threads. Minimum spacings and edge distances for screws shall be as specified in AISI S100. Screws covered by sheathing materials shall have low profile heads.

3.2.3 Anchors

Anchors shall be of the type, size, and location as required.

3.2.4 Powder-Actuated Fasteners

Powder-actuated fasteners shall be of the type, size, and location as required.

3.3 INSTALLATION

Install cold-formed framing in accordance with ASTM C1007 and AISI S200.

Install cold-formed steel framing according to AISI S202 and to manufacturer's written instructions unless more stringent requirements are indicated.

3.3.1 Tracks

Provide accurately aligned runners at top and bottom of studs. Install sealer gasket under bottom of track on concrete slab or foundation. Anchor tracks as indicated in design calculations. Butt weld joints in tracks or splice with stud inserts. Fasteners shall be at least 3 inches from the edge of concrete slabs.

3.3.2 Studs

Cut studs square and set with firm bearing against webs of top and bottom tracks. Position studs vertically in tracks and space as indicated in design. Do not splice studs. Provide at least two studs at jambs of doors and other openings 2 feet wide or larger. Provide jack studs over openings, as necessary, to maintain indicated stud spacing. Provide tripled studs at corners, positioned to receive interior and exterior finishes. Fasten studs to top and bottom tracks by welding or screwing both flanges to the tracks. Framed wall openings shall include headers and supporting components as shown on the drawings. Headers shall be installed in all openings that are larger than the stud spacing in a wall. In curtain wall construction, provide for vertical movement where studs connect to the structural frame. Provide horizontal bracing in accordance with the design calculations and AISI S100. Bracing shall be not less than the following:

LOAD	HEIGHT	BRACING
Wind load only	Up to 10 feet	One row at mid-height
	Over 10 feet	Rows 5'-0" o.c. maximum
Axial load	Up to 10 feet	Two rows at 1/3 points
	Over 10 feet	Rows 3'-4" o.c. maximum

3.3.3 Joists and Trusses

a. Provide a stud directly under each joist or truss. The maximum spacing of studs as indicated shall be maintained.

b. Install, bridge, and brace cold-formed steel trusses according to AISI S200, AISI S214, AISI's "Code of Standard Practice for Cold-Formed Steel Structural Framing," and manufacturer's written instructions unless more stringent requirements are indicated.

c. Install temporary bracing and supports. Maintain braces and supports

in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

d. Do not alter, cut, or remove framing members or connections of trusses.

3.3.4 Erection Tolerances

a. Framing members which will be covered by finishes such as wallboard, plaster, or ceramic tile set in a mortar setting bed, shall be within the following limits:

(1) Layout of walls and partitions: 1/4 inch from intended position;

(2) Plates and runners: 1/4 inch in 8 feet from a straight line;

(3) Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and

(4) Face of framing members: 1/4 inch in 8 feet from a true plane.

b. Framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive shall be within the following limits:

(1) Layout of walls and partitions: 1/4 inch from intended position;

(2) Plates and runners: 1/8 inch in 8 feet from a straight line;

(3) Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and

(4) Face of framing members: 1/8 inch in 8 feet from a true plane.

-- End of Section --

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SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2016) Code of Standard Practice for Steel Buildings and Bridges

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.6.2	(2020) Square Head Set Screws and Slotted Headless Set Screws (Inch Series)
ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.21.2M	(1999; R 2014) Lock Washers (Metric Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.3	(2020) Safety Requirements for Powder-Actuated Fastening Systems American National Standard for Construction and Demolition Operations

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A786/A786M	(2015; R 2021) Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B221M	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
ASTM C1513	(2018) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
ASTM D1187/D1187M	(1997; R 2018) Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(2016) Primer, Alkyd, Anti-Corrosive for Metal

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2017) Metal Bar Grating Manual
NAAMM MBG 532	(2019) Heavy Duty Metal Bar Grating Manual

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3	(2018) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the

office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Floor Gratings G, DO

Bollards/Pipe Guards; G, DO

Roof Hatch Guards and Gate, Fabrication and Installation Drawings; G, DO

Embedded Angles and Plates, Installation Drawings; G, DO

Roof Hatch, Installation Drawings; G, RO

SD-03 Product Data

Floor Gratings; G, DO

Roof Hatch; G, DO

Roof Hatch Guards and Gate; G, DO

1.3 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.4 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

1.5 MISCELLANEOUS REQUIREMENTS

1.5.1 Fabrication Drawings

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303.

1.5.2 Installation Drawings

Submit templates, erection, and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation in relation to the building construction.

PART 2 PRODUCTS

2.1 MATERIALS

Provide exposed fastenings of compatible materials (avoid contact of dissimilar metals). Coordinate color and finish with the material to which fastenings are applied.

2.1.1 Structural Carbon Steel

Provide in accordance with ASTM A36/A36M.

2.1.2 Structural Tubing

Provide in accordance with ASTM A500/A500M.

2.1.3 Steel Pipe

Provide in accordance with ASTM A53/A53M, Type E or S, Grade B.

2.1.4 Fittings for Steel Pipe

Provide standard malleable iron fittings in accordance with ASTM A47/A47M.

2.1.5 Gratings

a. Provide gray cast iron in accordance with ASTM A48/A48M, Class 40.

b. Provide metal plank grating, non-slip requirement, steel in accordance with ASTM A653/A653M, Z275 G90.

c. Provide metal bar type grating in accordance with NAAMM MBG 531 and NAAMM MBG 532.

2.1.6 Floor Plates, Patterned

Provide floor plate in accordance with ASTM A786/A786M. Provide steel plate not less than 14 gage.

2.1.7 Anchor Bolts

Provide in accordance with ASTM F1554. Where exposed, provide anchor bolts of the same material, color, and finish as the metal to which they are applied.

2.1.7.1 Lag Screws and Bolts

Provide in accordance with ASME B18.2.1, type and grade best suited for the purpose.

2.1.7.2 Toggle Bolts

Provide in accordance with ASME B18.2.1.

2.1.7.3 Bolts, Nuts, Studs and Rivets

Provide in accordance with ASME B18.2.2 or ASTM A307.

2.1.7.4 Powder Actuated Fasteners

Follow safety provisions in accordance with ASSP A10.3.

2.1.7.5 Screws

Provide in accordance with ASME B18.2.1, ASME B18.6.2, ASME B18.6.3 and ASTM C1513.

2.1.7.6 Washers

Provide plain washers in accordance with ASME B18.22M, ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers in accordance with ASME B18.21.2M, ASME B18.21.1.

2.1.7.7 Welded Headed Shear Studs

Provide in accordance with ASTM A108.

2.1.8 Aluminum Alloy Products

Provide in accordance with ASTM B209M, ASTM B209 for sheet plate, ASTM B221M, ASTM B221M, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings. Provide aluminum extrusions at least 1/8 inch thick and aluminum plate or sheet at least 0.050 inch thick.

2.2 FABRICATION FINISHES

2.2.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Provide galvanizing in accordance with ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, Z275 G90.

2.2.2 Galvanize

Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.2.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint in accordance with ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat, with a torch, surfaces to which stick or paste material will be applied. Heat to a temperature sufficient to melt the metals in the stick or paste. Spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.2.4 Shop Cleaning and Painting

2.2.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete must be free of dirt and grease prior to embed. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints. Shop coat these surfaces with rust prevention.

2.2.4.2 Pretreatment, Priming and Painting

Apply pre-treatment, primer, and paint in accordance with manufacturer's

printed instructions.

2.2.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.2.6 Aluminum Surfaces

2.2.6.1 Surface Condition

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.2.6.2 Aluminum Finishes

Unexposed sheet, plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF45. Unless otherwise specified, provide all other aluminum items with a standard mill finishor anodized finish. Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations. Provide in accordance with AA DAF45. Provide a polished satin finish on items to be anodized.

2.3 FLOOR GRATINGS

Design steel grating in accordance with NAAMM MBG 531 and NAAMM MBG 532 for bar type gratings, or in accordance with manufacturer's charts for plank grating. Galvanize steel floor gratings.

a. Design floor gratings to support a stress live load of 300 pounds per square foot for the spans indicated, with maximum deflection of L/240.

2.4 BOLLARDS/PIPE GUARDS

Provide 1/2 inch prime coated weight steel pipe in accordance with ASTM A53/A53M. Anchor posts in concrete as indicated and fill solidly with concrete with minimum compressive strength of 3000 psi.

2.5 MISCELLANEOUS PLATES AND SHAPES

Provide items that do not form a part of the structural steel framework, such as lintels, sill angles,support framing for the roof hatch, and miscellaneous mountings and frames. Provide lintels fabricated from structural steel shapes over openings in masonry walls and partitions as indicated and as required to support wall loads over openings. Provide with connections and fasteners. Construct to have at least 8 in bearing on masonry at each end.

Provide angles and plates in accordance with ASTM A36/A36M, for embedment as indicated. Galvanize embedded items exposed to the elements in accordance with ASTM A123/A123M.

2.6 ROOF HATCH

Provide roof hatch with aluminum or zinc-coated steel sheets not less than 14 gauge with 3 inch beaded flange, welded and ground at corners. Provide

a minimum clear opening of 36 by 42 inches. .

Provide as follows:

a. Insulated cover (door) and curb with one inch thick rigid fiberboard insulation, covered and protected by aluminum sheet or zinc-coated steel liner of not less than 26 gage. Provide with mounting flanges for securing to roof deck. Provide curb so that curb height is a minimum of 8" above highest point of the roof membrane. Provide curbs with integral metal cap flashing of the same gage and metal as the curb, fully welded and ground at corners for weather tightness.

b. Hatch completely assembled, with pintle hinges, compression spring operators enclosed in telescopic tubes, positive snap latches with turn handles on inside and outside, and neoprene draft seals. Provide fasteners for padlocking from the inside. Provide covers with automatic hold-open arms complete with grip handle to permit one hand release. Cover action must be smooth through its entire range of motion with an operating pressure of approximately 30 pounds.

c. Roof Hatch Guards and Gate- Provide roof hatch guardrailing and self-closing gate that complies with OSHA requirements. See contract drawings for additional information. Provide attachment information with subittal verifying that attachment method willnot void the roof warranty.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated in accordance with manufacturer's instructions. Verify all field dimensions prior to fabrication. Include materials and parts necessary to complete each assembly, whether indicated or not. Miss-alignment and miss-sizing of holes for fasteners is cause for rejection. Conceal fastenings where practicable. Joints exposed to weather must be watertight.

3.2 WORKMANSHIP

Provide miscellaneous metalwork that is true and accurate in shape, size, and profile. Make angles and lines continuous and straight. Make curves consistent, smooth and unfaceted. Provide continuous welding along the entire area of contact except where tack welding is permitted. Do not tack weld exposed connections. Unless otherwise indicated and approved, provide a smooth finish on exposed surfaces. Provide countersuck rivets where exposed. Provide coped and mitered corner joints aligned flush and without gaps.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage as necessary, whether indicated or not, for fastening miscellaneous metal items securely in place. Include slotted inserts, expansion shields, powder-driven fasteners, toggle bolts (when approved for concrete), through bolts for masonry, headed shear studs, machine and carriage bolts for steel, through bolts, lag bolts, and screws for wood. Do not use wood plugs. Provide non-ferrous attachments for non-ferrous metal. Provide exposed fastenings of compatible materials (avoid contact of dissimilar metals), that generally match in color and finish the surfaces to which they are applied. Conceal fastenings where

practicable. Provide all fasteners flush with the surfaces they fasten, unless indicated otherwise. Test a minimum of 2 bolt, nut, and washer assemblies from each certified mill batch in a tension measuring device at the job site prior to the beginning of bolting start-up.

3.4 BUILT-IN WORK

Where necessary and not otherwise indicated, form built-in metal work for anchorage with concrete or masonry. Provide built-in metal work in ample time for securing in place as the work progresses.

3.5 WELDING

Perform welding, welding inspection, and corrective welding in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation. Provide welded headed shear studs in accordance with AWS D1.1/D1.1M, Clause 7, except as otherwise specified. Provide in accordance with the safety requirements of EM 385-1-1.

3.6 DISSIMILAR METALS

Where dissimilar metals are in contact, protect surfaces with a coating in accordance with MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect in accordance with ASTM D1187/D1187M, asphalt-base emulsion. Clean surfaces with metal shavings from installation at the end of each work day.

3.7 PREPARATION

3.7.1 Material Coatings and Surfaces

Remove rust preventive coating just prior to field erection, using a remover approved by the metal manufacturer. Surfaces, when assembled, must be free of rust, grease, dirt and other foreign matter.

3.7.2 Environmental Conditions

Do not clean or paint surfaces when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than minus 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer. Metal surfaces to be painted must be dry for a minimum of 48 hours prior to the application of primer or paint.

3.8 COVER PLATES AND FRAMES

Provide tops of cover plates and frames flush with finished surface. Test for trip hazards and adjust for any encountered lippage.

3.9 ROOF HATCH AND RAILINGSInstall according to manufacutrer's instructions. Coordinate installation with 07 54 19 POLYVINYL-CHLORIDE ROOFING to provide a complete wethertight warranty of the roof system.

3.10 INSTALLATION OF BOLLARDS/PIPE GUARDS

Set bollards/pipe guards vertically in concrete piers. Fill hollow cores with concrete having a compressive strength of 3000 psi.

3.11 INSTALLATION MISCELLANEOUS PLATES AND SHAPES

Provide lintels fabricated from structural steel shapes over openings in masonry walls and partitions as indicated and as required to support wall loads over openings. Provide with connections and fasteners. Construct to have at least 8 inches bearing on masonry at each end.

-- End of Section --

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SECTION 05 51 00

METAL STAIRS

08/23

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SECTION 05 51 00

METAL STAIRS
08/23

PART 1 GENERAL

Section 05 05 23.16 STRUCTURAL WELDING applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.6.1	(2016) Wood Screws (Inch Series)
ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)
ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A512	(2006; R 2012) Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A575	(2020) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural,

	High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G, DO

Submit in conjunction with fabrication drawings for 05 52 00 METAL RAILINGS.

SD-03 Product Data

Steel Pan Stairs; G, DO

Steel Stairs; G, DO

SD-05 Design Data

Structural Calculations; G, DO

SD-07 Certificates

Welding Procedures; G, RO

Welder Qualification; G, RO

1.3 QUALITY CONTROL

1.3.1 Qualifications for Welding Work

Submit welding procedures in accordance with AWS D1.1/D1.1M. Make test specimens in the presence of the Contracting Officer, and have the specimens tested by an approved testing laboratory at the Contractor's expense.

Certify welder qualification by tests in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. In addition, perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, ensure

that two test welds are retested immediately and that each test weld is made and passes. Failure in the immediate retest requires that the welder be retested after further practice or training and a complete set of test welds be made.

1.4 QUALITY ASSURANCE

1.4.1 Fabrication Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 325, AISC 326, ASCE 7-16, and State of Colorado Building Code. Fabrication drawings will not be reproductions of contract drawings. Sign and seal fabrication drawings by a registered professional engineer. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Clearly highlight any deviations from the details shown on the contract drawings highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

1.4.2 Structural Calculations

Provide structural calculations signed by a licensed professional engineer with structural experience. Calculations shall show that the members and connections are adequately sized for the loads imposed on the steel stairs. Calculations shall include the connections to the rest of the building, necessary vertical supports, and the design of anchor bolts.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit complete and detailed fabrication drawings for metal stair system used in accordance with the design specifications referenced in this section.

2.2 FABRICATION

Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, before cleaning and treating surfaces and applying surface finishes, including zinc coatings.

2.2.1 General Fabrication

Stair system shall comply with NFPA 101, specifically section 40.2.5.3 Industrial Equipment Access minimum requirements. Where the drawings and/or specifications exceed these requirements, the drawings and specifications shall govern. Prepare and submit shop drawings with detailed plans and elevations and with details of sections and connections. Also detail the placement drawings, diagrams, and templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchorage devices.

Use materials of size and thicknesses indicated or, if not indicated, of the size and thickness necessary to produce a finished product that is strong enough and durable enough for its intended use. Work the materials to the dimensions indicated on approved detail drawings, using proven methods of fabrication and support. Use the type of materials indicated or specified for the various components of work.

Form exposed work true to line and level, with accurate angles and surfaces and with straight sharp edges. Ease exposed edges to a radius of approximately 1/32 inch, and bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Continuously weld corners and seams in accordance with the recommendations of AWS D1.1/D1.1M. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use Phillips flat-head (countersunk) screws or bolts.

Provide and coordinate anchorage of the type indicated for the supporting structure. Fabricate anchoring devices, and space them as indicated and as necessary to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified as fabricated from cold-finished or cold-rolled stock.

2.2.2 Steel Pan Stairs

2.2.2.1 General

Joining pieces by welding. Fabricate units so that bolts and other fastenings do not appear on finished surfaces. Make joints true and tight, and connections between parts lighttight. Grind continuous welds smooth where exposed.

Construct metal stair units to sizes and arrangements indicated to support a minimum live load of 100 pounds per square foot. Provide framing, hangers, columns, struts, clips, brackets, bearing plates, and other components as required for the support of stairs and platforms.

2.2.2.2 Stair Framing

Fabricate stringers of structural steel channels, or plates, or a combination thereof as indicated. Provide closures for exposed ends of strings.

Construct platforms of structural steel channel headers and miscellaneous framing members as indicated. Bolt headers to stringers and newels, and bolt framing members to stringers and headers.

2.2.2.3 Riser, Subtread, Landings, and Subplatform Metal Pans

Form metal pans of 0.1084-inch (12-gage) structural steel sheets, conforming to ASTM A1011/A1011M, Grade 36. Shape the pans to the configuration indicated.

Construct risers and subtread metal pans with steel angle supporting brackets welded to stringers. Secure metal pans to brackets with rivets or welds. Secure subplatform metal pans to platform frames with welds.

2.2.2.4 Metal Safety Nosings

Between stringers, provide abrasive cast metal safety nosings, 2 inches wide by the full length of the step. Equip each nosing with integral anchors for embedding in the pan fill material, and space the anchors not more than 4 inches from each end and not more than 15 inches on center.

2.2.2.5 Steel Framing for Concrete Stairs

When necessary, modify fabricated units to fit actual dimensions of the supporting structure. Join steel components by welding. Provide 14-gage steel risers unless otherwise indicated. Arrange components to receive finish materials as indicated.

2.3 COMPONENTS

2.3.1 Steel Stairs

Provide steel stairs complete with stringers, metal-pan concrete-filled treads and landings, columns, handrails, and necessary bolts and other fastenings.

2.3.1.1 Design Loads

Design stairs to sustain a live load of not less than 100 pounds per square foot, or a concentrated load of 300 lb applied where it is most critical. Except for a commercial product, design and fabricate steel stairs to conform to AISC 360. Design fire stairs to conform to NFPA 101.

2.3.1.2 Materials

Provide steel stairs of welded construction except that bolts may be used where welding is not practicable. Do not use screw or screw-type connections.

a. Structural Steel: ASTM A36/A36M.

Before fabrication, obtain necessary field measurements and verify drawing dimensions.

c. Clean metal surfaces free of mill scale, flake rust, and rust pitting before shop finishing. Weld permanent connections. Finish welds flush and smooth on surfaces that will be exposed after installation.

2.3.2 Concrete Inserts

Threaded-type concrete inserts consisting of galvanized ferrous castings, internally threaded to receive 3/4-inch diameter machine bolts; either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M, and hot-dip-galvanized in accordance with ASTM A153/A153M.

2.3.3 Fasteners

Select galvanized zinc-coated fasteners conforming to ASTM A153/A153M for

exterior applications or where the fasteners are built into exterior walls or floor systems. Select the fasteners for the type, grade, and class required for the installation of steel stair items:

a. Standard/regular hexagon-head bolts and nuts, conforming to ASTM A307, Grade A.

b. Square-head lag bolts conforming to ASME B18.2.1.

c. Cadmium-plated steel machine screws, conforming to ASME B18.6.3.

d. Flat-head carbon steel wood screws, conforming to ASME B18.6.1.

e. Plain, round, general-assembly-grade, carbon steel washers, conforming to ASME B18.21.1.

f. Helical-spring, carbon steel lockwashers, conforming to ASME B18.2.1.

2.4 MATERIALS

2.4.1 Structural Steel Plates, Shapes and Bars

Structural size shapes and plates, conforming to ASTM A36/A36M, unless otherwise noted, except bent or cold-formed plates.

Steel plates - bent or cold-formed, conforming to ASTM A283/A283M, Grade C.

Steel bars and bar-size shapes, conforming to ASTM A36/A36M, unless otherwise noted for steel bars and bar-size shapes.

2.4.2 Structural Steel Tubing

Provide the following:

a. Structural steel tubing, hot-formed, welded or seamless, conforming to ASTM A500/A500M, Grade B, unless otherwise noted.

2.4.3 Hot-Rolled Carbon Steel Bars

Provide the following:

a. Hot-rolled carbon steel bars and bar-size shapes, conforming to ASTM A575, grade as selected by the fabricator.

2.4.4 Cold-Finished Steel Bars

Provide the following:

a. Cold-finished steel bars conforming to ASTM A108, grade as selected by the fabricator.

2.4.5 Hot-Rolled Carbon Steel Sheets and Strips

Provide the following:

a. Hot-rolled carbon sheets and strips conforming to ASTM A568/A568M and ASTM A1011/A1011M, pickled and oiled.

2.4.6 Cold-Rolled Carbon Steel Sheets

Provide the following:

a. Cold-rolled carbon steel sheets conforming to ASTM A1008/A1008M.

2.4.7 Galvanized Carbon Steel Sheets

Provide the following:

a. Galvanized carbon steel sheets conforming to ASTM A653/A653M, with galvanizing conforming to ASTM A653/A653M and ASTM A924/A924M.

2.4.8 Cold-Drawn Steel Tubing

Provide the following:

a. Cold-drawn steel tubing conforming to ASTM A512, sunk drawn, butt-welded, cold-finished, and stress-relieved.

2.4.9 Steel Pipe

Provide the following:

a. Steel pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

PART 3 EXECUTION

3.1 PREPARATION

See 09 90 00 PAINTS AND COATINGS for painting requirements of the stair system. Clean surfaces thoroughly before installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions. Examine materials upon arrival at site. Notify the carrier and manufacturer of any damage.

Protect installed products until completion of project. Touch up, repair or replace, damaged products before substantial completion

3.2 INSTALLATION

Install in accordance with the manufacturer's instructions and approved submittals. Install in proper relationship with adjacent construction.

Install items at locations indicated, according to the manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Ensure that exposed fastenings are compatible with generally match the color and finish of, and harmonize with the material to which they are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners is cause for rejection. Conceal fastenings where practicable. Select thickness of metal and details of assembly and supports that adequately strengthen and stiffen the construction. Form joints exposed to the weather to exclude water.

3.2.1 Field Preparation

Remove rust-preventive coating just before field erection, using a remover approved by the coating manufacturer. Provide surfaces, when assembled, free of rust, grease, dirt and other foreign matter.

3.2.2 Field Welding

Comply with AWS D1.1/D1.1M in executing manual shielded-metal arc welding, (for appearance and quality of new welds) and in correcting existing welding. Clean all field welds suitable for painting.

3.2.3 Safety Nosings

Completely embed nosing in concrete before the initial set of the concrete occurs and finish flush with the top of the concrete surface.

3.2.4 Painting

Apply touch-up paint to any shop finished surfaces that were damaged during installation. See 09 90 00 PAINTS AND COATINGS for additional information on painting.

-- End of Section --

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SECTION 05 51 33

METAL LADDERS

08/24

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SECTION 05 51 33

METAL LADDERS
08/24

PART 1 GENERAL

1.1 Applicability

This specification is intended for both the mezzanine access ladder and the roof hatch ladder. Material shall be steel or aluminum and are the contractor's option. Ladders can be either pre-fabricated or constructed by the contractor.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes

AMERICAN LADDER INSTITUTE (ALI)

ALI A14.3	(2008; R 2018) Ladders - Fixed - Safety Requirements

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B108/B108M	(2019) Standard Specification for

	Aluminum-Alloy Permanent Mold Castings
ASTM B209/B209M	(2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM D1187/D1187M	(1997; R 2018) Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(2016) Primer, Alkyd, Anti-Corrosive for Metal

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.23	(Nov 2016) Ladders

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Ladders; G, DO

SD-07 Certificates

Fabricator Certification for Ladder Assembly

1.4 CERTIFICATES

Provide fabricator certification for ladder assembly stating that the ladder and associated components have been fabricated according to the requirements of 29 CFR 1910.23.

1.5 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.6 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Structural Carbon Steel

ASTM A36/A36M.

2.1.2 Structural Tubing

ASTM A500/A500M.

2.1.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B.

2.1.4 Fittings for Steel Pipe

Standard malleable iron fittings ASTM A47/A47M.

2.1.5 Aluminum Alloy Products

Conform to ASTM B209/B209M for sheet plate, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings, as applicable. Provide aluminum extrusions at least 1/8 inch thick and aluminum plate or sheet at least 0.050 inch thick.

2.2 FABRICATION FINISHES

2.2.1 Shop Cleaning and Painting

2.2.1.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean.

2.2.1.2 Painting

Paint in accordance with 09 90 00 PAINTS AND COATINGS if steel ladders are used.

2.2.2 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.2.3 Aluminum Surfaces

2.2.3.1 Surface Condition

Before finishes are applied, remove roll marks, scratches, rolled-in scratches, kinks, stains, pits, orange peel, die marks, structural streaks, and other defects which will affect uniform appearance of finished surfaces.

2.2.3.2 Aluminum Finishes

Unexposed plate and extrusions may have mill finish as fabricated. Sandblast castings' finish, medium, AA DAF45. Unless otherwise specified,

provide all other aluminum items with standard mill finish. Provide a coating thickness not less than that specified for protective and decorative type finishes for items used in interior locations or architectural Class I type finish for items used in exterior locations in AA DAF45.

2.3 LADDERS

Fabricate vertical ladders conforming to 29 CFR 1910.23 and Section 5 of ALI A14.3. Design assembly, including rung connections and methods of attachment, to support a live load of 300 pounds per rung, or 1000 pounds point load, or 100 pounds per square foot load applied downward. Use 2 1/2 by 3/8 inch steel flats for stringers and 3/4 inch diameter steel rods for rungs. Ladder rungs, step and cleats must be not less than 10 inches and not more than 16 inches wide, spaced not les than 10 inches and no more than 14 inches apart, plug welded or soldered and headed into stringers. Install ladders so that the maximum perpendicular distance from the centerline of the steps or rungs, or grab bars, or both, to the nearest permanent object in the back of the ladder or to the finished wall surface will not be less than 7 inches. Provide heavy clip angles riveted or bolted to the stringer and drilled for not less than two 1/2 inch diameter expansion bolts. Provide intermediate clip angles not over 48 inches on centers. The top rung of the ladder must be level with the top of the access level, parapet or landing served by the ladder except for hatches or wells. Extend the side rails of through or side step ladders 42 inches above the access level. Provide ladder access protective swing gates at the top of access/egress level. See 05 50 13 MISCELLANEOUS METAL FABRICATIONS for ladder railings and swing gates. The drawings must indicate ladder locations and details of critical dimensions and materials.

Ladder for the roof hatch shall have extendable grab bars that extend at least 42 inches above the hatch curb. The mezzanine access ladder shall have grab bars that are permanently fixed to the sides of the ladder that extend at least 42 inches above the top of the mezzanine floor.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, according to manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Provide exposed fastenings of compatible materials, generally matching in color and finish, and harmonize with the material to which fastenings are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners will be cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports must provide strength and stiffness. Formed joints exposed to the weather to exclude water. Items listed below require additional procedures.

3.2 WORKMANSHIP

Metalwork must be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching must produce clean true lines and surfaces. Continuously weld along the entire area of contact. Do not tack weld exposed connections of work in place. Grind exposed

welds smooth. Provide smooth finish on exposed surfaces of work in place, unless otherwise approved. Where tight fits are required, mill joints. Cope or miter corner joints, well formed, and in true alignment. Install in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening metal items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion anchors, and powder-actuated fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine bolts, carriage bolts and powder-actuated threaded studs for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

3.4 WELDING

Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

3.5 FINISHES

3.5.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with a coat conforming to MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

3.6 LADDERS

Secure to the adjacent construction with the clip angles attached to the stringer. Secure to concrete with not less than two 1/2 inch diameter expansion bolts. Install intermediate clip angles not over 48 inches on center. Install brackets as required for securing of ladders welded or bolted to structural steel or built into the concrete. Ends of ladders must not rest upon floor.

-- End of Section --

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SECTION 05 52 00

METAL RAILINGS

08/23

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SECTION 05 52 00

METAL RAILINGS
08/23

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2024) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel

Hardware

ASTM A283/A283M	(2024) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A512	(2006; R 2012) Standard Specification for Cold-Drawn Buttweld Carbon Steel Mechanical Tubing
ASTM A575	(2020) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 521	(2001; R 2012) Pipe Railing Systems Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G,DO

Submit in conjunction with 05 51 00 METAL STAIRS

SD-03 Product Data

Concrete Inserts

Steel Guardrails and Handrails; G, DO

Anchorage and Fastening Systems

SD-05 Design Data

Design Calculations For Steel Connections; G, DO

SD-06 Test Reports

Welding Inspections; G, RO

SD-07 Certificates

Welder Qualification; G, RO

1.3 QUALITY CONTROL

1.3.1 Welding Procedures

Section 05 05 23.16 STRUCTURAL WELDING applies to work specified in this section.

Submit results of welding inspections testing in accordance with AWS D1.1/D1.1M by an approved testing laboratory at the Contractor's expense. Provide laboratory welding inspection results to Contracting Officer.

1.3.2 Welder Qualification

Submit certified welder qualification by tests in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. In addition, perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, conduct an immediate retest of two test welds and ensure that each test weld passes. Failure in the immediate retest will require that the welder be retested after further practice or training and make a complete set of test welds.

1.4 QUALITY ASSURANCE

1.4.1 Fabrication Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 325, AISC 326, ASCE 7-16, State of Colorado Building Code, OSHA CFR 1910.29, and NFPA 101. Fabrication drawings will not be reproductions of contract drawings. Sign and seal fabrication drawings by a registered professional engineer. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. See drawings for minimum requirements. Removable sections of the guardrail shall be designed so that the weight of the sections can be safely lifted by two people. Gate for the ladder shall be self-closing. Clearly highlight any deviations from the details shown on the contract drawings highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

1.4.2 Delegated Connection Design

Design structural steel connection indicated in the contract documents per AISC 360. Submit design calculations for steel connections signed and sealed by a registered professional engineer.

PART 2 PRODUCTS

2.1 FABRICATION

Preassemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling.

Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, before cleaning, treating, and applying surface finishes, including zinc coatings.

Provide railing and handrail detail plans and elevations. Provide details of sections and connections to walls, floors, and other anchor points and substrates specific to this project (not generic details). Also detail setting drawings, diagrams, templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchors. Note that guardrails on the mezzanine are intended to be mounted to the face of the mezzanine and not in the floor of the mezzanine concrete slab and shall be designed accordingly.

Use materials of size and thicknesses indicated or, if not indicated, of the size and thickness necessary to produce adequate strength and durability in the finished product for its intended use. Work the materials to the dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use the type of materials indicated or specified for the various components of work.

Form exposed work true to line and level, with accurate angles and surfaces and straight sharp edges. Ensure that all exposed edges are eased to a radius of approximately 1/32 inch. Bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Weld corners and seams continuously and in accordance with the recommendations of AWS D1.1/D1.1M. Grind exposed welds smooth and flush to match and blend with adjoining surfaces and make suiitable for painting.

Form the exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use countersunk Phillips flathead screws or bolts.

Provide anchorage and fastening Systems which are coordinated with the supporting structure. Fabricate anchoring devices and space as indicated and as required to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified to be fabricated from cold-finished or cold-rolled stock.

2.1.1 Steel Handrails

Fabricate joint posts, rail, and corners by one of the following methods:

a. Flush-type rail fittings of commercial standard, welded and ground smooth, with railing splice locks secured with 3/8 inch hexagonal-recessed-head setscrews.

b. Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove-welding joints, and grinding smooth. Butt railing splices and reinforce them by a

tight-fitting interior sleeve not less than 6 inches long.

c. Railings may be bent at corners in lieu of jointing, provided that bends are made in suitable jigs and the pipe is not crushed.

2.1.2 Protective Coating

Shop-prime the steelwork as indicated in accordance with Section 09 90 00 PAINTS AND COATINGS except the following:

a. Steel surfaces encased in concrete

b. Steel surfaces for welding

c. High-strength bolt-connected contact surfaces

2.2 COMPONENTS

2.2.1 Structural Steel Plates, Shapes and Bars

Provide structural-size shapes and plates, except plates to be bent or cold-formed, conforming to ASTM A36/A36M, unless otherwise noted.

Provide steel plates, to be bent or cold-formed, conforming to ASTM A283/A283M, Grade C.

Provide steel bars and bar-size shapes conforming to ASTM A36/A36M, unless otherwise noted.

2.2.2 Structural-Steel Tubing

Provide structural-steel tubing, hot-formed, welded or seamless, conforming to ASTM A500/A500M, Grade B, unless otherwise noted.

2.2.3 Hot-Rolled Carbon Steel Bars

Provide bars and bar-size shapes conforming to ASTM A575, grade as selected by the fabricator.

2.2.4 Cold-Finished Steel Bars

Provide cold-finished steel bars conforming to ASTM A108, grade as selected by the fabricator.

2.2.5 Cold-Drawn Steel Tubing

Provide tubing conforming to ASTM A512, sunk-drawn, butt-welded, cold-finished, and stress-relieved.

2.2.6 Steel Pipe

Provide pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

2.2.7 Concrete Inserts

Provide threaded-type concrete inserts consisting of galvanized ferrous castings, internally threaded to receive 3/4 inch diameter machine bolts;

either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M, hot-dip galvanized in accordance with ASTM A153/A153M.

2.2.8 Fasteners

Provide galvanized zinc-coated fasteners in accordance with ASTM A153/A153M used for exterior applications or where built into exterior walls or floor systems. Select fasteners for the type, grade, and class required for the installation of steel stair items.

Provide standard hexagon-head bolts, conforming to ASTM A307, Grade A.

2.2.9 Steel Guardrails And Handrails

Design handrails to resist a single concentrated load of 200 lb in any direction at any point of the top of the rail or 50 lb per foot applied horizontally to the top of the rail, whichever is more severe. NAAMM AMP 521, provide the same size rail and post. Provide pipe collars of the same material and finish as the handrail and posts.

2.2.9.1 Steel Handrails

Provide steel handrails, including inserts in concrete, steel pipe conforming to ASTM A53/A53M or structural tubing conforming to ASTM A500/A500M, Grade A or B of equivalent strength. Provide steel railings of 2 inch nominal size, shop-painted.

PART 3 EXECUTION

3.1 PREPARATION

Adjust guardrails and handrails before securing in place in order to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than 8 feet on center. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

a. Anchor rail ends into concrete with round steel flanges welded to rail ends and anchored into the wall construction with lead expansion shields and bolts.

b. Anchor rail ends to steel with round steel flanges welded to tail ends to the structural-steel members.

Secure handrails to walls by means of wall brackets and wall return fitting at handrail ends. Handrails mounted to guardrails shall be welded. Locate brackets not more than 60 inches on center. Provide wall return fittings of steel. Secure wall brackets and wall return fittings to building construction as follows:

For stud partition anchorage, use toggle bolts having square heads.

3.2 INSTALLATION

3.2.1 Steel Handrail

Install handrail welded to stringers or mounted to wall with brackets. Secure rail ends by steel pipe flanges anchored by expansion shields and bolts.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Welding

Ensure that procedures of manual shielded metal arc welding, appearance and quality of welds made, and methods used in correcting welding work comply with AWS D1.1/D1.1M. Welds shall be ground smooth.

-- End of Section --

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SECTION 06 10 00

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08/16, CHG 2: 11/18

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SECTION 06 10 00

ROUGH CARPENTRY
08/16, CHG 2: 11/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN LUMBER STANDARDS COMMITTEE (ALSC)

ALSC PS 20	(2015) American Softwood Lumber Standard

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.5.2.1M	(2006; R 2011) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2010) Metric Round Head Square Neck Bolts
ASME B18.6.1	(2016) Wood Screws (Inch Series)

AMERICAN WOOD COUNCIL (AWC)

AWC NDS	(2015) National Design Specification (NDS) for Wood Construction
AWC WFCM	(2012) Wood Frame Construction Manual for One- and Two-Family Dwellings

AMERICAN WOOD PROTECTION ASSOCIATION (AWPA)

AWPA M2	(2019) Standard for the Inspection of Preservative Treated Wood Products for Industrial Use
AWPA M6	(2013) Brands Used on Preservative Treated Materials

APA - THE ENGINEERED WOOD ASSOCIATION (APA)

APA E445	(2002) Performance Standards and Qualification Policy for Structural-Use

	Panels (APA PRP-108)
APA F405	(19) Product Guide: Performance Rated Panels
APA L870	(2010) Voluntary Product Standard, PS 1-09, Structural Plywood
APA S350	(2014) PS 2-10, Performance Standard for Wood-Based Structural-Use Panels

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM D2898	(2010; R 2017) Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM F547	(2017) Standard Terminology of Nails for Use with Wood and Wood-Base Materials
ASTM F1667/F1667M	(2021a) Standard Specification for Driven Fasteners: Nails, Spikes, and Staples

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

FM GLOBAL (FM)

FM 4435	(2013) Roof Perimeter Flashing

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1923	(Rev A; Notice 1; Notice 2; Notice 3; Notice 4) Shield, Expansion (Lag, Machine

	and Externally Threaded Wedge Bolt Anchors)
CID A-A-1924	(Rev A; Notice 3) Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors
CID A-A-1925	(Rev A; Notice 3) Shield Expansion (Nail Anchors)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Nailers and Nailing Strips

Drawings of field erection details, including materials and methods of fastening nailers in conformance with Factory Mutual wind uplift rated systems specified in other Sections of these specifications. Submit in conjunction with07 54 19 POLYVINYL-CHLORIDE ROOFING or other systems as appropriate.

SD-03 Product Data

Fire-retardant Treatment

Adhesives

SD-06 Test Reports

Preservative-treated Lumber and Plywood

SD-07 Certificates

Certificates of Grade

Preservative Treatment

1.3 DELIVERY AND STORAGE

Deliver materials to the site in an undamaged condition. Store, protect, handle, and install prefabricated structural elements in accordance with manufacturer's instructions and as specified. Store materials off the ground to provide proper ventilation, with drainage to avoid standing water, and protection against ground moisture and dampness. Store materials with a moisture barrier at both the ground level and as a cover forming a well ventilated enclosure. Adhere to requirements for stacking, lifting, bracing, cutting, notching, and special fastening requirements. Do not use materials that have visible moisture or biological growth. Remove defective and damaged materials and provide new materials. Store separated reusable wood waste convenient to cutting station and area of work.

1.4 GRADING AND MARKING

1.4.1 Lumber

Mark each piece of framing and board lumber or each bundle of small pieces of lumber with the grade mark of a recognized association or independent inspection agency. Such association or agency must be certified by the Board of Review, American Lumber Standards Committee, to grade the species used. Surfaces that are to be exposed to view must not bear grademarks, stamps, or any type of identifying mark. Hammer marking will be permitted on timbers when all surfaces will be exposed to view.

1.4.2 Plywood

Mark each sheet with the mark of a recognized association or independent inspection agency that maintains continuing control over the quality of the plywood. The mark must identify the plywood by species group or span rating, exposure durability classification, grade, and compliance with APA L870. Surfaces that are to be exposed to view must not bear grademarks or other types of identifying marks.

1.4.3 Preservative-Treated Lumber and Plywood

The Contractor is responsible for the quality of treated wood products. Each treated piece must be inspected in accordance with AWPA M2 and permanently marked or branded, by the producer, in accordance with AWPA M6. The Contractor must provide Contracting Officer's Representative (COR) with the inspection report of an approved independent inspection agency that offered products comply with applicable AWPA Standards. The appropriate Quality Mark on each piece will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

1.4.4 Fire-Retardant Treated Lumber

Mark each piece in accordance with AWPA M6, except pieces that are to be natural or transparent finished. In addition, exterior fire-retardant lumber must be distinguished by a permanent penetrating blue stain. Labels of a nationally recognized independent testing agency will be accepted as evidence of conformance to the fire-retardant requirements of AWPA M6.

1.5 SIZES AND SURFACING

ALSC PS 20 for dressed sizes of yard and structural lumber. Lumber must be surfaced four sides. Size references, unless otherwise specified, are nominal sizes, and actual sizes must be within manufacturing tolerances allowed by the standard under which the product is produced. Other measurements are IP or SI standard.

1.6 MOISTURE CONTENT

Air-dry or kiln-dry lumber. Kiln-dry treated lumber after treatment. Maximum moisture content of wood products must be as follows at the time of delivery to the job site:

a. Framing lumber and board, 19 percent maximum

b. Timbers 5 inches and thicker, 25 percent maximum

c. Materials other than lumber; moisture content must be in accordance with standard under which the product is produced

1.7 PRESERVATIVE TREATMENT

a. 0.25 pcf intended for above ground use.

b. 0.40 pcf intended for ground contact and fresh water use. The following items must be preservative treated:

(1) Wood framing, woodwork, and plywood up to and including the subflooring at the first-floor level of structures having crawl spaces when the bottoms of such items are 24 inches or less from the earth underneath.

(2) Exterior wood steps, platforms, and railings; and all wood framing of open, roofed structures.

(3) Wood sills, soles, plates, furring, and sleepers that are less than 24 inches from the ground, furring and nailers that are set into or in contact with concrete or masonry.

(4) Nailers, edge strips, crickets, curbs, and cants for roof decks.

1.8 FIRE-RETARDANT TREATMENT

Fire-retardant treated wood must be pressure treated Treatment and performance inspection must be by an independent and qualified testing agency that establishes performance ratings. Each piece or bundle of treated material must bear identification of the testing agency to indicate performance in accordance with such rating. Treated materials to be exposed to rain wetting must be subjected to an accelerated weathering technique in accordance with ASTM D2898 prior to being tested. Such items which will not be inside a building, and such items which will be exposed to heat or high humidity, must receive exterior fire-retardant treatment. Fire-retardant-treated wood products must be free of halogens, sulfates, ammonium phosphate, and formaldehyde.

1.9 CERTIFICATIONS

1.9.1 Certified Wood Grades

Provide certificates of grade from the grading agency on graded but unmarked lumber or plywood attesting that materials meet the grade requirements specified herein.

PART 2 PRODUCTS

2.1 PLYWOOD

APA L870, APA S350, APA E445, and APA F405 respectively.

2.1.1 Other Uses

2.1.1.1 Plywood

Plywood for Telecom Room walls. A or B Grade, Exposure 1.

2.2 OTHER MATERIALS

2.2.1 Miscellaneous Wood Members

2.2.1.1 Nonstress Graded Members

Members must include bridging, corner bracing, furring, grounds, and nailing strips. Members must be in accordance with TABLE I for the species used. Sizes must be as follows unless otherwise shown:

Member	Size inch
Bridging	1 x 3 or 1 x 4 for use between members 2 x 12 and smaller; 2 x 4 for use between members larger than 2 x 12.
Corner bracing	1 x 4.
Furring	1 x 3
Grounds	Plaster thickness by 38.
Nailing strips	1 x 3 or 1 x 4 when used as shingle base or interior finish, otherwise 2 inch stock.

2.2.1.2 Blocking

Blocking must be standard or number 2 grade.

2.2.2 Adhesives

Comply with applicable regulations regarding toxic and hazardous materials and as specified. Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36.

2.3 ROUGH HARDWARE

Unless otherwise indicated or specified, rough hardware must be of the type and size necessary for the project requirements. Sizes, types, and spacing of fastenings of manufactured building materials must be as recommended by the product manufacturer unless otherwise indicated or specified. Rough hardware exposed to the weather or embedded in or in contact with preservative treated wood, exterior masonry, or concrete walls or slabs must be hot-dip zinc-coated in accordance with

ASTM A153/A153M. Nails and fastenings for fire-retardant treated lumber and woodwork exposed to the weather must be copper alloy or hot-dipped galvanized fasteners as recommended by the treated wood manufacturer.

2.3.1 Bolts, Nuts, Studs, and Rivets

ASME B18.2.1, ASME B18.5.2.1M, ASME B18.5.2.2M and ASME B18.2.2.

2.3.2 Anchor Bolts

ASTM A307, size as indicated, complete with nuts and washers.

2.3.3 Expansion Shields

CID A-A-1923, CID A-A-1924, and CID A-A-1925. Except as shown otherwise, maximum size of devices must be 3/8 inch.

2.3.4 Lag Screws and Lag Bolts

ASME B18.2.1.

2.3.5 Wood Screws

ASME B18.6.1.

2.3.6 Nails

ASTM F547, size and type best suited for purpose. For sheathing and subflooring, length of nails must be sufficient to extend 1 inch into supports. In general, 8-penny or larger nails must be used for nailing through 1 inch thick lumber and for toe nailing 2 inch thick lumber; 16-penny or larger nails must be used for nailing through 2 inch thick lumber. Nails used with treated lumber and sheathing must be hot-dipped galvanized in accordance with ASTM A153/A153M. Nailing must be in accordance with the recommended nailing schedule contained in AWC WFCM. Where detailed nailing requirements are not specified, nail size and spacing must be sufficient to develop an adequate strength for the connection. The connection's strength must be verified against the nail capacity tables in AWC NDS. Reasonable judgment backed by experience must ensure that the designed connection will not cause the wood to split. If a load situation exceeds a reasonable limit for nails, a specialized connector must be used.

2.3.7 Wire Nails

ASTM F1667/F1667M.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Conform to AWC WFCM unless otherwise indicated or specified. Select lumber sizes to minimize waste. Fit framing lumber and other rough carpentry, set accurately to the required lines and levels, and secure in place in a rigid manner. Do not splice framing members between bearing points. Set joists, rafters, and purlins with their crown edge up. Frame

members for the passage of pipes, conduits, and ducts. Do not cut or bore structural members for the passage of ducts or pipes without approval. Reinforce all members damaged by such cutting or boring by means of specially formed and approved sheet metal or bar steel shapes, or remove and provide new, as approved. Provide as necessary for the proper completion of the work all framing members not indicated or specified. Spiking and nailing not indicated or specified otherwise must be in accordance with the Nailing Schedule contained in ICC IBC; perform bolting in an approved manner. Spikes, nails, and bolts must be drawn up tight.

3.2 MISCELLANEOUS

3.2.1 Wood Roof Nailers, Edge Strips, Crickets, Curbs, and Cants

Provide sizes and configurations indicated or specified and anchored securely to continuous construction.

3.2.1.1 Roof Edge Strips and Nailers

Provide at perimeter of roof, around openings through roof, and where roofs abut walls, curbs, and other vertical surfaces. Except where indicated otherwise, nailers must be 6 inches wide and the same thickness as the insulation. Anchor nailers securely to underlying construction. Anchor perimeter nailers in accordance with FM 4435.

3.2.2 Wood Blocking

Provide proper sizes and shapes at proper locations for the installation and attachment of wood and other finish materials, fixtures, equipment, and items indicated or specified.

3.2.3 Temporary Closures

Provide with hinged doors and padlocks and install during construction at exterior doorways and other ground level openings that are not otherwise closed. Cover windows and other unprotected openings with polyethylene or other approved material, stretched on wood frames. Provide dustproof barrier partitions to isolate areas as directed.

3.2.4 Temporary Centering, Bracing, and Shoring

Forms and centering for cast-in-place concrete work are specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3 WASTE MANAGEMENT OF WOOD PRODUCTS

In accordance with the Waste Management Plan and as specified. Separate and reuse scrap sheet materials larger than 2 square feet , framing members larger than 16 inches , and multiple offcuts of any size larger than 12 inches . Clearly separate damaged wood and other scrap lumber for acceptable alternative uses on site, including bracing, blocking, cripples, ties, and shims.

Separate treated, stained, painted, and contaminated wood and place in designated area for hazardous materials. Dispose of according to local regulations. Prevent sawdust and wood shavings from entering the storm

drainage system. Do not burn scrap lumber that has been pressure treated, or lumber that is less than one year old.

-- End of Section --

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SECTION 07 22 00

ROOF AND DECK INSULATION
08/23

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2017) Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM C1177/C1177M	(2017) Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
ASTM C1289	(2023) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM 4470	(2022) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction
FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalg

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Provide submittals in conjunction with 07 54 19 POLYVINYL-CHLORIDE ROOFING for a complete and warrantable system. Submit the following in accordance

with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Insulation Board Layout and Attachment; G, DO

SD-03 Product Data

Insulation; G, DO

Cover Board; G, DO

Fasteners; G, DO

Recycled Content For Insulation;

SD-05 Design Data

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SD-06 Test Reports

Flame Spread Rating; G, DO

SD-07 Certificates

Installer Qualifications; G, DO

SD-08 Manufacturer's Instructions

Nails and Fasteners;

Roof Insulation;

1.2.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.3 SHOP DRAWINGS

Submit insulation board layout and attachment indicating methods of attachment and spacing of fasteners on each board, transitions, thicknesses of materials, and closure and termination conditions. Show locations of ridges, crickets, interface with, and slope.

1.4 PRODUCT DATA

Include data for material descriptions, recommendations for product shelf life, requirements for cover board or coatings, and precautions for flammability and toxicity. Include data to verify compatibility of sealants with insulation.

1.5 MANUFACTURER'S INSTRUCTIONS

Include field of roof, perimeter, and corner attachment requirements.

Provide a complete description of installation sequencing for each phase of the roofing system. Include weatherproofing procedures.

1.6 QUALITY CONTROL

Provide certification of installer qualifications from the insulation manufacturer confirming the specific installer has the required qualifications for installing the specific roof insulation system(s) indicated.

1.7 WIND RESISTANCE REQUIREMENTS

The complete roof system assembly must be rated and installed to resist wind loads calculated in accordance with ASCE 7 and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Coordinate with roof covering attachment requirements and submit wind resistance test certification, attachment patterns for field, perimeter, and corner roof areas along with perimeter and corner boundary dimensions.

1.8 FIRE PERFORMANCE REQUIREMENTS

1.8.1 Insulation in Roof Systems

Comply with the requirements of ICC IBC or FM 4470. Roof insulation must have a flame spread rating of 75 or less when tested in accordance with ASTM E84. Additional documentation of compliance with flame spread rating is not required when insulation of the type used for this project as part of the specific roof assembly is listed and labeled as FM Class 1 approved.

1.8.2 Fire Resistance Ratings for Roofs

Provide in accordance with ICC IBC Chapter 7 and Table 721.1(3) Min Fire and Smoke Protection For Floor and Roof Systems.

1.9 DELIVERY, STORAGE, AND HANDLING

1.9.1 Delivery

Deliver materials to the project site in manufacturer's unopened and undamaged standard commercial containers bearing the following legible information:

a. Name of manufacturer

b. Brand designation

c. Specification number, type, and class, as applicable, where materials are covered by a referenced specification

Deliver materials in sufficient quantity to allow continuity of the work.

1.9.2 Storage and Handling

Store and handle materials in accordance with manufacturer's printed instructions. Protect from damage, exposure to open flame or other ignition sources, wetting, condensation, and moisture absorption. Keep materials wrapped and separated from off-gassing materials (such as drying paints and adhesives). Do not use materials that have visible moisture or

biological growth. Store in an enclosed building or trailer that provides a dry, adequately ventilated environment. Replace damaged material with new material.

1.10 ENVIRONMENTAL CONDITIONS

As per manufacturer's recommendations or Government's instructions, do not install roof insulation during inclement weather or when air temperature is below 40 degrees F and interior humidity is 45 percent or greater, or when there is visible ice, frost, or moisture on the roof deck.

1.11 PROTECTION

1.11.1 Completed Work

Cover completed work with cover board for the duration of construction. Avoid traffic on completed work particularly when ambient temperature is above 80 degrees F. Replace crushed or damaged insulation prior to roof surface installation.

PART 2 PRODUCTS

2.1 INSULATION

2.1.1 Insulation Types

Provide one, or an assembly of a maximum of three, of the following roof insulation materials. Provide roof insulation that is compatible with attachment methods for the specified insulation and roof membrane.

a. Polyisocyanurate Board: Provide in accordance with ASTM C1289 REV A Type II, fibrous felt or glass mat membrane both sides, except minimum compressive strength of 25 pounds per square inch (psi).

2.1.2 Recycled Materials

Provide thermal insulation materials containing recycled content. Unless specified otherwise, the minimum required recycled content for listed materials are:

Perlite Composition Board:	23 percent postconsumer paper
Polyisocyanurate/polyurethane:	9 percent recovered material
Cellular Glass Insulation:	60 percent recovered content
Fiber (felt) or Fiber composite:	75 percent recovered content

Provide data identifying percentage of recycled content for insulation.

2.1.3 Prohibited Materials

Products that contain high ozone depleting or high Global Warming Potential (GWP) blowing agents are prohibited. For a list of acceptable

substitute foam blowing agents for the type of insulation used see https://www.epa.gov/snap/foam-blowing-agents.

2.1.4 Insulation Thickness

As necessary to provide the thermal resistance (R-value) indicated. Base calculation on the R-value for aged insulation.

2.1.5 Tapered Roof Insulation

One layer of the tapered roof insulation assembly must be factory tapered to a slope of not less than one in 1/2 inch per foot. Factory fabricate mitered joints from two diagonally cut boards or one board shaped to provide required slopes.

2.1.6 Cants and Tapered Edge Strips

Provide preformed cants and tapered edge strips of the same material as the roof insulation. When unavailable, provide pressure-preservative treated wood, or rigid perlite board cants and edge strips as recommended by the roofing manufacturer for the specific application, unless otherwise indicated. Face of cant strips to incline at 45 degrees with a minimum vertical height of 4 inches. Taper edge strips at a rate of one to 1 1/2 inch per foot down to approximately 1/8 inch thick.

2.2 COVER BOARD

For use as a thermal barrier (underlayment), fire barrier (overlayment), or cover board for hot-mopped, torched-down, or adhesive-applied roofing membrane over roof insulation.

2.2.1 Glass Mat Gypsum Roof Board

ASTM C1177/C1177M, 0 Flame Spread and 0 Smoke Developed when tested in accordance with ASTM E84, 500 psi, Class A, non-combustible, 1/2 inch thick, 4 by 8 feet board size.

2.3 FASTENERS

Provide flush-driven fasteners through flat round or hexagonal steel or plastic plates. Provide zinc-coated steel plates, flat round not less than 1 3/8 inch diameter, hexagonal not less than 28 gage. Provide high-density plastic plates, molded thermoplastic with smooth top surface, reinforcing ribs and not less than 3 inches in diameter. Fully recess fastener head into plastic plate after it is driven. Form plates to prevent dishing. Do not use bell or cup shaped plates. Provide fasteners in accordance with insulation manufacturer's recommendations for holding power when driven, or a minimum of 120 pounds each in steel deck, whichever is the higher minimum. Provide fasteners for steel or concrete decks in accordance with FM APP GUIDE (https://www.approvalguide.com/) for Class I roof deck construction, and spaced to withstand uplift pressure of 90 pounds per square foot.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

3.1.1 Surface Inspection

Ensure surfaces are clean, smooth, and dry prior to application. Check roof deck surfaces for defects before starting work.

The Contractor must inspect and approve the surfaces immediately before starting installation. Prior to installing , perform the following:

a. Examine steel decks to ensure that panels are properly secured to structural members and to each other and that surfaces of top flanges are flat or slightly convex.b. In the presence of the Contracting Officer perform the following surface dryness test on concrete substrates:

(1) Foaming: When poured on the deck, one pint of asphalt when heated in the range of 350 to 400 degrees F, does not foam upon contact.

(2) Strippability: After asphalt used in the foaming test application has cooled to ambient temperatures, test coating for adherence. Should a portion of the sample be readily stripped clean from surface, do not consider surface to be dry and do not start application. Should rain occur during application, stop work and do not resume until surface has been re-tested by method above and found dry.

e. Prior to installing any roof system on a concrete deck, moisture test the deck in accordance with ASTM D4263. The deck is acceptable for roof system application when there is no visible moisture on underside of plastic sheet after 24 hours.

3.1.2 Surface Preparation

Correct defects and inaccuracies in roof deck surface to eliminate poor drainage from hollow or low spots.3.2 INSTALLATION OF VAPOR RETARDER

Install vapor retarder in direct contact with roof deck surface . Unless otherwise specified, vapor retarder must consist of either two plies of No. 15 asphalt-saturated felt, two plies of asphalt-coated glass felt, or one layer of asphalt-saturated felt base sheet. Lay vapor retarder at right angles to direction of slope. Install first ply of felt or base sheet as specified herein for the specific deck. Apply second ply of 2-ply vapor retarder system using asphalt at rate of 20 to 35 lbs per 100 square feet, applied within plus or minus 25 degrees F of EVT. Do not heat asphalt above asphalt's FBT or 525 degrees F, whichever is less. Use thermometers to check temperatures during heating and application. Completely seal side and end laps. Asphalt must be visible beyond all edges of each ply as it is being installed. Lay plies free of wrinkles, buckles, creases or fishmouths. Do not walk on mopped surfaces while asphalt is sticky. Press out air bubbles to obtain complete adhesion between surfaces. At walls, eaves, rakes, and other vertical surfaces, extend vapor retarder organic felts or separate plies 9 inches, with not less than 9 inches on the substrate, and the extended portion turned back and mopped in over the top of the insulation. At roof penetrations other than walls, eaves and rakes, and vertical surfaces, extend vapor retarder or separate plies 9 inches to form a lap folded back over the edge of the

insulation. Provide asphalt roof cement under the vapor retarder for at least 9 inches from walls, eaves, rakes and other penetrations.

3.2.1 Vapor Retarder on Poured or Precast Concrete Decks

Evenly mop primed substrate with asphalt at a rate of 20 to 35 lbs per 100 square feet before installing vapor retarder. Lay first ply of two-ply system with each sheet lapping 19 inches over the preceding sheet. Lap ends not less than 4 inches. Stagger laps a minimum of 12 inches. For a vapor retarder consisting of one layer of asphalt base sheet, provide side and end laps not less than 4 inches. Stagger laps a minimum of 12 inches. Cement base sheets together with a solid mopping of asphalt.

3.3 INSULATION INSTALLATION

Fully adhere to concrete deck and to subsequent boards. Apply insulation in two layers with staggered joints when total required thickness of insulation exceeds 1/2 inch. Lay insulation so that continuous longitudinal joints are perpendicular to direction of roofing and end joints of each course are staggered with those of adjoining courses. When using multiple layers of insulation, provide joints of each succeeding layer that are parallel and offset in both directions with respect to the layer below. Keep insulation 1/2 inch clear of vertical surfaces penetrating and projecting from roof surface. Verify required slopes to each roof drain.

3.3.1 Special Precautions for Installation of Foam Insulation

3.3.1.1 Polyisocyanurate Insulation

Where polyisocyanurate foam board insulation is provided, install cover board over top surface of foam board insulation. Stagger joints of insulation with respect to foam board insulation below.

3.3.2 Cant Strips

Where indicated, provide cant strips at intersections of roof with walls, parapets, and curbs extending above roof. Wood cant strips must bear on and be anchored to wood blocking. Fit cant strips flush to vertical surfaces. Where possible, nail cant strips to adjoining surfaces. Where cant strips are installed against non-nailable materials, install in an approved adhesive.

3.4 PROTECTION

3.4.1 Protection of Applied Insulation

Completely cover each day's installation of insulation with finished roofing on same day. Phased construction is not permitted. Protect open spaces between insulation and parapets or other walls and spaces at curbs, scuttles, and expansion joints, until permanent roofing and flashing are applied. Storing, walking, wheeling, or trucking directly on insulation or on roofed surfaces is not permitted. Provide smooth, clean board or plank walkways, runways, and platforms near supports, as necessary, to distribute weight in accordance with indicated live load limits of roof construction . Protect exposed edges of insulation with cutoffs at the end of each workday or whenever precipitation is imminent. Cutoffs must be two layers of bituminous-saturated felt set in plastic bituminous cement . Fill all profile voids in cutoffs to prevent trapping moisture

below the membrane. Remove cutoffs when work resumes.

3.4.2 Damaged Work and Materials

Restore work and materials that become damaged during construction to original condition or replace with new materials.

3.5 INSPECTION

Establish and maintain inspection procedures to assure compliance of the installed roof insulation with Contract requirements. Remove, replace, correct in an approved manner, any work found not in compliance. Quality control must include, but is not limited to, the following:

a. Observation of environmental conditions; number and skill level of insulation workers; start and end time of work.

b. Verification of certification, listing or label compliance with FM Data Sheets.

c. Verification of proper storage and handling of insulation and vapor retarder materials before, during, and after installation.

d. Inspection of vapor retarder application, including edge envelopes and mechanical fastening.

e. Inspection of mechanical fasteners; type, number, length, and spacing.

f. Coordination with other materials, cants, sleepers, and nailing strips.

g. Inspection of insulation joint orientation and laps between layers, joint width and bearing of edges of insulation on deck.

h. Installation of cutoffs and proper joining of work on subsequent days.

i. Continuation of complete roofing system installation to cover insulation installed same day.

-- End of Section --

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SECTION 07 27 10

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SECTION 07 27 10

BUILDING AIR BARRIER SYSTEM
08/23

PART 1 GENERAL

1.1 SUMMARY

This Section specifies the construction and quality control of the installation of an air barrier system. Construct the air barrier system indicated, taking responsibility for the means, methods, and workmanship of the installation of the air barrier system. The air barrier must be contiguous and connected across all surfaces of the enclosed air barrier envelope indicated.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referenced within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4541	(2022) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM E2178	(2021a) Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials
ASTM E2357	(2018) Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 285	(2023) Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components

1.3 DEFINITIONS

The following terms as they apply to this section:

1.3.1 Air Barrier Accessory

Products designated to maintain air tightness between air barrier materials, air barrier assemblies and air barrier components, to fasten

them to the structure of the building, or both (e.g., sealants, tapes, backer rods, transition membranes, fasteners, strapping, primers).

1.3.2 Air Barrier Assembly

The combination of air barrier materials and air barrier accessories that are designated and designed within the environmental separator to act as a continuous barrier to the movement of air through the environmental separator.

1.3.3 Air Barrier Component

Pre-manufactured elements such as windows, doors, dampers and service elements that are installed in the environmental separator.

1.3.4 Air Barrier Envelope

The combination of air barrier assemblies and air barrier components, connected by air barrier accessories that are designed to provide a continuous barrier to the movement of air through an environmental separator. There may be more than one air barrier envelope in a single building. Also known as Air Barrier System.

1.3.5 Air Barrier Material

A building material that is designed, tested or produced to provide the primary resistance to airflow through an air barrier assembly of a building enclosure.

1.3.6 Air Barrier System

Same as AIR BARRIER ENVELOPE.

1.3.7 Air Leakage Rate

The rate of airflow (CFM) driven through a unit surface area (sq.ft.) of an assembly or system by a unit static pressure difference (Pa) across the assembly. (example: 0.25 CFM/sq.ft. @ 75 Pa)

1.3.8 Air Leakage

The total airflow (CFM) driven through the air barrier system by a unit static pressure difference (Pa) across the air barrier envelope. (example: 6500 CFM @ 75 Pa)

1.3.9 Air Permeance

The tested rate of airflow (CFM) through a unit area (sq.ft.) of a material driven by unit static pressure difference (Pa) across the material (example: 0.004 CFM/sq.ft. @ 75 Pa) as established by ASTM E2178.

1.3.10 Environmental Separator

The parts of a building that separate the controlled interior environment from the uncontrolled exterior environment, or that separate spaces within a building that have dissimilar environments. Also known as the Control Layer.

1.3.11 Vapor Permeance

Vapor permeance is separated into three classes based on the water vapor permeance of a material as tested via ASTM E96/E96M

Class I Vapor Barrier/Retarder	0.1 perm or less
Class II Vapor Barrier/Retarder	0.1 perm to 1.0 perm
Class III Vapor Barrier/Retarder	1.0 perm to 10 perm

1.4 PREPARATORY PHASE OR PRECONSTRUCTION CONFERENCE

Organize pre-construction conferences between the air barrier inspector and the sub-contractors involved in the construction of, or penetration of, the air barrier system to discuss where the work of each sub-contractor begins and ends, the sequence of installation, and each sub-contractor's responsibility to ensure airtight joints, junctures, penetrations and transitions between materials. Discuss the products, and assemblies of products specified in the different sections to be installed by the different sub-contractors.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Air Barrier System Shop Drawings; G, DO, Manufacturer produced warranted air barrier system

SD-03 Product Data

Air Barrier System Product Data; G, DO

SD-06 Test Reports

Inspection Report; G, RO

PART 2 PRODUCTS

2.1 AIR BARRIER

Provide air barrier system of compatible parts from one or several manufacturers coordinated by the Contractor or provide a single warranted system provided by a primary manufacturer. The air barrier system as part of a tested exterior wall assembly must meet the conditions of acceptance as tested in accordance with NFPA 285. Materials used for roof assembly air barrier must conform to the appropriate UL and FM wind and fire requirements for the specified roof and wall assemblies.

If a complete air barrier system from a single manufacturer is utilized, whether warranted or not warranted, the air barrier system must conform to ASTM E2357.

Materials in the following categories, as used in the air barrier system or assembly of the exterior wall system, are tested and are required to conform to ASTM E2178: Self-adhered sheet membranes, fluid applied membranes, spray polyurethane foam, mechanically fastened commercial building wrap, factory bonded membranes to sheathing, and adhesive backed commercial building wrap and accessory products.

Other materials used as an air barrier such as concrete, glass, wood, metal or gypsum board may or may not conform to ASTM E2178 but are acceptable provided that when integrated into the air barrier system or assemblies they are not subject to material or environmental induced degradation in their final produced state once incorporated in the permanent construction.

All materials used must be identifiable through manufacturer testing data or literature to be compatible with all the attached or adjoining materials or substrates used in the system.

Provide Air Barrier System Shop Drawings and Air Barrier System Product Data.

PART 3 EXECUTION

3.1 QUALITY CONTROL

3.1.1 Documentation and Reporting

Document the entire installation process on daily job site reports. These reports include information on the Installer, substrates, substrate preparation, products used, ambient and substrate temperature, the location of the air barrier installation, the results of the quality control procedures, and testing results.

3.1.2 Quality Control Inspection and Testing

Conduct the following tests and inspections as applicable in the presence of the Contracting Officer during installation of the air barrier system, and submit quality control reports as indicated below.

a. Provide a Daily Report of Observations with a copy to the Contracting Officer.

b. Inspect to assure continuity of the air barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.

c. Inspect to assure structural support of the air barrier system to withstand design air pressures.

d. Inspect to assure concrete surfaces receiving air barrier materials are smooth, clean, and free of cavities, protrusions and mortar droppings, with joints struck flush or as required by the manufacturer of the air barrier material.

e. Inspect and test to assure site conditions for application temperature, and dryness of substrates are within guidelines.

f. Inspect to assure substrate surfaces are properly primed, if applicable, and in accordance with manufacturer's instructions. Priming must extend at least 2 inches beyond the air barrier material to make it obvious that the primer was applied to the substrate before the air barrier material.

g. Inspect to assure laps in materials are at least a 2-inch minimum, shingled in the correct direction or mastic applied in accordance with manufacturer's recommendations, and with no fishmouths.

h. Inspect to assure that a roller has been used to enhance adhesion. Identify any defects such as fishmouths, wrinkles, areas of lost adhesion, and improper curing. Note the intended remedy for the deficiencies.

i. Measure application thickness of liquid applied materials to assure that manufacturer's specifications for the specific substrate are met.

j. Inspect to assure that the correct materials are installed for compatibility.

k. Inspect to assure proper transitions for change in direction and structural support at gaps.

l. Inspect to assure proper connection between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

m. Perform adhesion tests for fluid-applied and self-adhered air barrier membranes to assure that the manufacturer's specified adhesion strength properties are met. Determine the bond strength of coatings to substrate in accordance with ASTM D4541.

n. Provide cohesion tests for spray polyurethane foam (SPF). Perform adhesion tests as follows: Using a coring tool remove a sample and determine the relative adhesion quality of the foam. If the foam is hard to remove and leaves small bits of foam on the substrate it is called cohesive foam failure and is considered the best adhesion. If the foam comes away from the substrate with some force but is clean, it is called a mechanical bond. If it comes away easily from the substrate, the adhesion is poor. Cohesive foam failure and a good mechanical bond are acceptable.

o. Provide written Inspection Report of all inspections aand tests performed.

3.2 REPAIR AND PROTECTION

Upon completion of inspection, sample removal and similar services, repair damaged construction and restore substrates, coatings and finishes. Protect construction exposed by or for quality control service activities, and protect repaired construction.

-- End of Section --

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SECTION 07 54 19

POLYVINYL-CHLORIDE ROOFING
08/23

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-22	(2022) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.24	(2022) Roofing - Safety Requirements for Low-Sloped Roofs

ASTM INTERNATIONAL (ASTM)

ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4434/D4434M	(2015) Standard Specification for Poly(Vinyl Chloride) Sheet Roofing
ASTM D6754/D6754M	(2010) Standard Specification for Ketone Ethylene Ester Based Sheet Roofing
ASTM E108	(2020a) Standard Test Methods for Fire Tests of Roof Coverings

FM GLOBAL (FM)

FM 4470	(2022) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction
FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalg

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 3621	(2017) Quality Control and Quality-assurance Guidelines for the Application of Membrane Roof Systems

NRCA 3740	(2005) The NRCA Waterproofing Manual
SINGLE PLY ROOFING INDUSTRY (SPRI)	
ANSI/SPRI/FM 4435/ES-1	(2017) Test Standard for Edge Systems Used with Low Slope Roofing Systems
UL SOLUTIONS (UL)	
UL 790	(2022) UL Standard for Safety Test Methods for Fire Tests of Roof Coverings

1.2 SUMMARY

Adhered polyvinyl-chloride (PVC) roof membrane system applied over insulation ovn top of a concrete roof decksubstrate. Incorporate air barrier in the roof assembly as specified in Section 07 22 00 ROOF AND DECK INSULATION and 07 27 10 BUILDING AIR BARRIER SYSTEM.

1.3 ASSEMBLY REQUIREMENTS

Provide roofing membrane sheet widths consistent with membrane attachment methods and wind uplift requirements, and as large as practical. In order to minimize joints and 3-way overlaps, prefabricated sheets are not accepted. Provide membrane which is free of defects and foreign material. Coordinate flashing work to permit continuous roof-surfacing operations. Install insulation and weatherproofed planned sections on the same day.

1.3.1 Fire Resistance

Complete roof system assembly:

a. Class A rated in accordance with ASTM E108, FM 4470, or UL 790; and

b. Be listed as Class I roof deck construction in FM APP GUIDE.

FM or UL approved components of the roof covering assembly must bear the appropriate FM or UL label.

1.3.2 Wind Uplift Resistance

Provide a complete roof system assembly that is rated and installed to resist wind loads calculated in accordance with ASCE 7-22 and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Do not install non-rated systems, except as approved by the Contracting Officer. Submit Engineering calculations, signed, sealed, and dated by a Registered Engineer validating the wind resistance in accordance with ASCE 7-22, and ANSI/SPRI/FM 4435/ES-1 of non-rated roof system. Base wind uplift measurements on a design wind speed in accordance with ASCE 7-22 and other applicable building code requirements.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.

Submit the following in concurrence with 06 10 00 ROUGH CARPENTRY, 07 22 00 ROOF AND DECK INSULATION, and 07 60 00 FLASHING AND SHEET METAL and in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, DO

Roof Plan; G, DO

SD-03 Product Data

PVC Roofing Membrane; G, DO

Bonding Adhesive

Flashing

Membrane Fasteners and Plates

Roof Insulation

Pre-Manufactured Accessories

Water Cutoffs

Information Card; G, RO

SD-05 Design Data

Wind Uplift Resistance; G, DO

SD-07 Certificates

Qualification of Manufacturer; G, RO

Qualifications of Applicator; G, RO

Fire Resistance classification

Minimum Polymer Thickness

Sample Warranty; G, RO

SD-08 Manufacturer's Instructions

Application Method;

Membrane Flashing; G, DO

Perimeter and High Wind Attachment

Auxiliary Fasteners

Pre-Manufactured Accessories

Cold Weather; G, RO

SD-11 Closeout Submittals

Warranty; G, RO

Information Card;

Instructions to Government Personnel;

1.4.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.5 QUALITY ASSURANCE

1.5.1 Qualification of Manufacturer

Polyvinyl-Chloride sheet roofing system manufacturer must have a minimum of 10 years experience in manufacturing PVC roofing products.

1.5.2 Qualifications of Applicator

Roofing system applicator must be approved, authorized, or licensed in writing by the PVC sheet roofing system manufacturer and have a minimum of five years experience as an approved, authorized, or licensed applicator with that manufacturer and be approved at a level capable of providing the specified warranty. Supply the names, locations and client contact information of five projects, within the previous three years, of similar size and scope that the applicator has constructed using the manufacturer's roofing products submitted for this project.

1.5.3 Conformance and Compatibility

Provide an entire roofing and flashing system that is in accordance with specified and indicated requirements, including fire and wind resistance.

1.5.4 Preroofing Conference

After approval of submittals and before performing roofing and insulation system installation work, hold a preroofing conference to review the following:

a. Drawings, including roof plan, specifications and submittals related to the roof work.

b. Roof system components installation;

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roofing substrate, and roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representative to roof manufacturer;

d. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing; and

e. Quality control(NRCA 3621) plan for the roof system installation;

f. Safety requirements.

Coordinate preroofing conference scheduling with the Contracting Officer. The conference must be attended by the Contractor, the Contracting Officer's designated personnel, personnel directly responsible for the installation of roofing and insulation, flashing and sheet metal work, mechanical and electrical work, lightning protection, safety tie-offs, other trades interfacing with the roof work, designated safety personnel trained to enforce and copy with ASSP A10.24, Fire Marshall, and a representative of the roofing materials manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items requiring resolution prior to start of roof work.

1.6 DETAIL DRAWINGS

Submit roof plan depicting wind loads and boundaries of enhanced perimeter and corner attachments of roof system components, location of perimeter half-sheets, spacing of perimeter, corner, and infield fasteners, as applicable. Provide drawings that reflect the project roof plan of each roof level and conditions indicated. Include all roof appurtenances in the drawings, including but not limited to, lightning protection and safety tie-offs. Submit detail drawings and specifications approved and furnished by the PVC membrane manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Delivery

Deliver materials in the manufacturer's original, unopened containers and rolls with labels intact and legible. Mark and remove wet or damaged materials from the site. Where materials are covered by a referenced specification number, the container must bear the specification number, type, class, and shelf life expiration date where applicable. Deliver materials in sufficient quantity to allow work to proceed without interruption.

1.7.2 Storage

Protect materials against moisture absorption and contamination or other damage. Avoid crushing or crinkling of roll materials. Store roll materials on end on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer. Do not store roll materials in buildings under construction until concrete, mortar, and plaster work is finished and dry. Maintain roll materials at temperatures above 50 degrees F for 24 hours immediately before application. Do not store materials outdoors unless approved by the Contracting Officer. Completely cover felts stored outdoors, on and off roof, with waterproof canvas protective covering. Do not use polyethylene sheet as a covering. Tie covering securely to pallets to make completely weatherproof. Provide sufficient ventilation to prevent condensation. Do not store more materials on roof than can be installed the same day and remove unused materials at end of each days work. Distribute materials temporarily stored on roof to stay within live load limits of the roof construction.

a. Maintain a minimum distance of 35 foot for stored flammable materials, including materials covered with shrink wraps, craft paper or tarps from torch/welding applications.

b. Immediately remove wet, contaminated or otherwise damaged or unsuitable materials from the site. Damaged materials may be marked by the Contracting Officer.

1.7.3 Handling

Prevent damage to edges and ends of roll materials. Do not install damaged materials in the work. Select and operate material handling equipment to prevent damage to materials or applied roofing.

1.8 ENVIRONMENTAL REQUIREMENTS

Do not install roofing system when air temperature is below 40 degrees F, during any form of precipitation, including fog, or when there is ice, frost, moisture, or any other visible dampness on the roof deck. Follow manufacturer's printed instructions for Cold Weather Installation.

1.9 SEQUENCING

Coordinate the work with other trades to ensure that components which are to be secured to or stripped into the roofing system are available and that permanent flashing and counterflashing in accordance with NRCA 3740, are installed as the work progresses. Ensure temporary protection measures are in place to preclude moisture intrusion or damage to installed materials. Apply roofing immediately following application of insulation as a continuous operation. Coordinate roofing operations with insulation work so that roof insulation applied each day is covered with roof membrane installation the same day.

1.10 WARRANTY

Provide roof system material and workmanship warranties. Provide revision or amendment to standard membrane manufacturer warranty as required to comply with the specified requirements. Provide a manufacturer's warranty that has no dollar limit, covers full system water-tightness, and has a minimum duration of 20 years. Submit sample certificate.

1.10.1 Roof Membrane Manufacturer Warranty

Furnish the roof membrane manufacturer's 20-year, no dollar limit roof system materials and installation workmanship warranty, including flashing, insulation as included in 07 22 00 ROOF AND DECK INSULATION, and accessories included in Section 07 60 00 FLASHING AND SHEET METAL. Provide warranty directly to the Government commencing at the time of Government's acceptance of the building. The warranty must state that:

a. If within the warranty period the roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, splits, tears, cracks, delaminates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the roof system assembly and correction of defective workmanship are the responsibility of the roof membrane manufacturer. All costs

associated with the repair or replacement work are the responsibility of the roof membrane manufacturer.

b. When the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification, emergency temporary repairs performed by others does not void the warranty.

1.10.2 Roofing System Installer Warranty

The roof system installer must warrant for a minimum period of two years that the roof system, as installed, is free from defects in installation workmanship, to include the roof membrane, flashing, insulation, accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Write the warranty directly to the Government. The roof system installer is responsible for correction of defective workmanship and replacement of damaged or affected materials. The roof system installer is responsible for all costs associated with the repair or replacement work.

1.10.3 Continuance of Warranty

Repair or replacement work that becomes necessary within the warranty period must be approved, as required, and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the manufacturer warranty for the remainder of the manufacturer warranty period.

PART 2 PRODUCTS

2.1 MATERIALS

Coordinate with other specification sections related to the roof work. Furnish a combination of specified materials that comprise a roof system acceptable to the roof membrane manufacturer and meeting specified requirements. Protect materials provided from defects and make suitable for the service and climatic conditions of the installation.

2.1.1 PVC Roof Membrane

Provide a minimum polymer thickness 0.08 inch reinforced PVC as specified herein. Provide PVC system capable of obtaining 20 year warranties and as listed in the applicable wind uplift and fire rating classification listings.

Submit Data as required by sections 06 10 00 ROUGH CARPENTRY (nailers) if required and 07 22 00 ROOF AND DECK INSULATION together with requirements of this section. Provide data that includes written acceptance by the roof membrane manufacturer of the insulation and other products and accessories to be provided by and warranted under the full system guarantee of the roof membrane manufacturer.

a. Coordinate with other specification sections related to the roof work. Furnish a combination of specified materials that comprise a roof system acceptable to the roof membrane manufacturer and meeting specified requirements. Provide materials free of defects and suitable for the service and climatic conditions of the installation. Provide warranted roof system in which all components are sourced from the PVC roof membrane manufacturer, including but not limited to all insulation, coverboards, accessories, adhesives and edge metal.

b. For each roof, furnish a typewritten information card for facility records and a card laminated in plastic and framed for interior display at roof access point, or a photoengraved 0.032 inch thick aluminum card for exterior display. Provide card that is 8 1/2 by 11 inches minimum. On the information card identify facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, membrane, number of plies, method of application, manufacturer, insulation and cover board system and thickness; presence of tapered insulation for primary drainage, presence of vapor retarder; date of completion; installing Contractor identification and contact information; membrane manufacturer warranty expiration, warranty reference number, and contact information. Install card at roof top or access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

2.1.2 Bonding Adhesive

Provide PVC membrane manufacturer's recommended adhesive, as supplied by roof membrane manufacturer, and recommended by the manufacturer's printed data for bonding of PVC membrane materials to acceptable insulation, wood, metal, concrete or other acceptable substrate materials. Do not use bonding adhesive to bond membrane materials to each other.

2.1.3 Water Cutoff Mastic/Water Block

As supplied by the roof membrane manufacturer and recommended by the manufacturer's printed data.

2.1.4 Membrane Flashing

Provide membrane flashing, including self-adhering membrane flashing, perimeter flashing, flashing around roof penetrations and prefabricated pipe seals, of a minimum polymer thickness 0.072 inch reinforced PVC for 20 year warranties, and utilized as recommended and supplied by the roof membrane manufacturer or minimum 0.072 inch thick reinforced PVC roof membrane and flashings for 20 year warranties. Submit certification from PVC membrane manufacturer that the proposed PVC membrane roofing product meets the minimum polymer thickness specified.

2.1.5 Membrane Fasteners and Plates

Coated, corrosion-resistant fasteners as recommended and supplied by the PVC roof membrane manufacturer and meeting the requirements of FM 4470 and FM RoofNav (www. roofnav.com) or FM APP GUIDE for Class I roof deck construction and the wind uplift resistance specified. Fasteners and plates to be supplied and warranted for the substrate type(s) by PVC membrane manufacturer and recommended by PVC membrane manufacturer's printed data.

2.1.5.1 Stress Plates, Bar or Rail for Fasteners

Utilize corrosion-resistant stress plates as recommended by the roof membrane manufacturer's printed instructions and meeting the requirements of FM 4470. Stress plates to be supplied by PVC roof membrane manufacturer. Form stress plates to prevent dishing or cupping. Manufacturer-supplied anchoring bar or rails may be utilized for high wind conditions.

2.1.5.2 Auxiliary Fasteners

Provide corrosion resistant screws, nails, or anchors suitable for intended attachment purpose and be recommended and supplied for use by the PVC roof membrane manufacturer.

2.1.6 Pre-manufactured Accessories

Provide pre-manufactured accessories that are manufacturer's standard for intended purpose, comply with the applicable specification section, are compatible with the membrane roof system and approved for use and supplied by the PVC roof membrane manufacturer. Provide pre-fabricated pipe flashings and safety tie-offs for the roof.

2.1.7 Roof Insulation

Provide insulation system and facer material compatible with membrane application specified and be approved and supplied by the PVC membrane roof manufacturer and as specified in Section 07 22 00 ROOF AND DECK INSULATION.

2.1.8 Wood Products

As specified in Section 06 10 00 ROUGH CARPENTRY, except that fire retardant treated materials must not be in contact with PVC membrane or PVC accessory products, unless approved by the membrane manufacturer and the Contracting Officer.

2.2 REINFORCED, PVC MEMBRANE

Provide reinforced polyvinyl chloride (PVC) membrane containing fibers or scrim, and complying with ASTM D4434/D4434M, Type IV, or ASTM D6754/D6754M, and in all cases provide 0.096 inch minimum thickness for application. Not withstanding the ASTM standards referenced, provide reinforced PVC roof membranes having the minimum, labeled thickness specified. PVC membrane thickness specified herein is exclusive of backing material on the bottom of fleece-backed membrane. Provide principal polymer used in manufacture of the membrane sheet as PVC, with width and length of PVC membrane roofing sheet consistent with membrane attachment methods and wind uplift requirements, and sheet size as large as practical. In order to minimize joints and 3-way overlaps, prefabricated sheets are not accepted. Maximum reinforced PVC membrane roofing sheet dimensions to be the maximum width obtainable from PVC membrane roof manufacturer in order to minimize seams in the field of the roof.

PART 3 EXECUTION

3.1 CONCRETE SURFACE DRYNESS

Prior to installing roof system on a concrete deck, including application of insulation or membrane materials, conduct a test for surface dryness in accordance with ASTM D4263. The deck is acceptable for roof system application when there is no visible moisture on underside of plastic sheet after 24 hours.

3.2 EXAMINATION

Ensure that the following conditions exist prior to application of the

roofing materials:

a. Do not install items that show visual evidence of biological growth.

b. Drains, curbs, control joints, expansion joints, perimeter walls, roof penetrating components, and equipment supports are in place.

c. Surfaces are rigid, clean, dry, smooth, and free from cracks, holes, and sharp changes in elevation.

d. Substrate is sloped to provide positive drainage.

e. Walls and vertical surfaces are constructed to receive counterflashing, and will permit mechanical fastening of the base flashing materials.

f. Treated wood nailers are in place on non-nailable surfaces, to permit nailing of base flashing at minimum height of 8 inches above finished roofing surface.

g. Pressure-preservative treated wood nailers are fastened in place at eaves, gable ends, openings, and intersections with vertical surfaces for securing of membrane, edging strips, attachment flanges of sheet metal, and roof fixtures.

h. PVC materials are not in contact with fire retardant treated wood, except as approved by the PVC membrane roof manufacturer and Contracting Officer.

k. Insulation boards are installed smoothly and evenly, and are not broken, cracked, or curled. There are no gaps in insulation board joints exceeding 1/4 inch in width. Insulation is attached as specified in Section 07 22 00 ROOF AND DECK INSULATION. Insulation is being roofed over on the same day the insulation is installed.

3.3 APPLICATION METHOD

Apply entire PVC membrane roofing utilizing combination adhered/protected membrane application methods. Apply roofing materials as specified herein unless approved otherwise by the Contracting Officer. Submit instructions including pattern and frequency of mechanical attachments required in the field for roof, corners, and perimeters to provide for the specified wind resistance

3.3.1 Special Precautions

a. Do not dilute coatings or sealants unless specifically recommended by the material manufacturer's printed application instructions. Do not thin liquid materials or cleaners used for cleaning PVC sheet.

b. Keep liquids in airtight containers, and keep containers closed except when removing materials.

c. Use liquid components, including adhesives, within their shelf life period. Store adhesives at 60 to 80 degrees F prior to use. Avoid excessive adhesive application and adhesive spills, as they can be destructive to some thermoplastic sheets and insulations; follow

adhesive manufacturer's printed application instructions. Mix and use liquid components in accordance with label directions and manufacturer's printed instructions.

d. Provide clean, dry cloths or pads for applying membrane cleaners and cleaning of membrane.

e. Do not use heat guns or open flame to expedite drying of adhesives or primers.

f. Require workmen and others who walk on the membrane to wear clean, soft-soled shoes to avoid damage to roofing materials.

g. Do not use equipment with sharp edges which could puncture the PVC membrane roofing sheet.

h. Shut down air intakes and related mechanical systems and seal open vents and air intakes when applying solvent-based materials in the area of the opening or intake. Coordinate shutdowns with the Contracting Officer.

i. Identify any combustible materials at or near heat seaming devices. Remove the combustible material and use particular caution around those combustible materials throughout the installation.

j. At no time will torch equipment be used for seams, repairs, or welding installations. Install all welded components and seams using heat guns within the strict written instructions of the membrane manufacturer.

k. All heat welding must be performed by an individual that has and maintains a NFPA 101 Hot Work Safety Certificate.

l. Upon completion of the heat seaming, establish a fire watch with the use of a thermal heat imager during the watch.

3.3.2 PVC Roofing Membrane

Provide a watertight roof membrane sheet free of contaminants and defects that might affect serviceability. Provide a uniform, straight, and flat edge. Provide and install only felt-backed membrane directly on concrete deck or other hard surface which may otherwise damage the membrane, absent the felt backing. Do not place non-felt-backed PVC membrane roofing sheet directly on concrete deck or other hard surface which may damage the membrane. Provide membrane overlap of a minimum of 3 inches at sides for adhered applications and 5.5-7 inches for mechanically fastened applications and minimum 4 inches at ends. Direction of laps must allow water to flow over and not against the lap. Install membrane joints that are free of wrinkles and fishmouths. During the day of installation, probe the entire length of hot-air-welded seams and correct deficiencies. Reweld defective areas. Cut out fishmouths, or damaged areas and cover the area with membrane using a continuous hot-air-welded seam on all sides. Probe test repairs for continuity. Hot-air-welded seams are to be accomplished in accordance with the PVC membrane roofing manufacturer's published requirements.

3.3.2.1 Nailing

Fasten membrane to nailers in accordance with the membrane manufacturer's approved instructions. Unless otherwise specified, stagger nails on 4 inch

centers maximum; stagger screws for sheet metal on 8 inch centers maximum; and install rows of fasteners at least 1/2 inch from edges of sheet metal.

3.3.2.2 Flashing

Flash all roof edges, projections through the roof and changes in roof planes. Seal the seam a minimum of 3 inches beyond the fasteners which attach the membrane to nailers. Secure the installed flashing at the top of the flashing a maximum of 12 inches on centers under the counterflashing or cap. Where possible, install prefabricated components for pipe seals and flashing accessories.

3.3.2.3 Expansion Joints

Cover expansion joints using Prefabricated covers or elastomeric flashing in accordance with the recommendations of the manufacturer.

3.3.2.4 Cutoffs

If work is terminated prior to weatherproofing the entire roof, seal the membrane to the roof deck. Also, seal flutes in metal decking along the cutoff edge. Pull the membrane free or cut to expose the insulation when resuming work and remove the cut insulation sheets used for fill-in. Do not use asphalt or coal-tar products for sealing.

3.3.3 Adhered Membrane Application

Layout membrane and side lap adjoining sheets in accordance with membrane manufacturer's printed installation instructions. Allow for sufficient membrane to form proper membrane terminations. Remove dusting agents and dirt from membrane and substrate areas where bonding adhesives are to be applied. Apply specified adhesive evenly and continuously to substrate and underside of sheets at rates recommended by the roof membrane manufacturer's printed application instructions. When adhesive is spray applied, roll with a paint roller to ensure proper contact and coverage. Do not apply bonding adhesive to surfaces of membrane in seam or lap areas. Allow adhesive to flash off or dry to consistency prescribed by manufacturer before adhering sheets to the substrate. When adhesive is peel and stick release paper-activated, follow manufacturer's printed instructions. Roll each sheet into adhesive slowly and evenly to avoid wrinkles; broom or roll the membrane to remove air pockets and fishmouths and to ensure adequately uniform bonding of sheet to substrate. Form field hot-air-welded laps or seams as specified and ensure that hot-air welded dimension is at width required by the membrane manufacturer's installation instructions. Check all seams and continuous hot-air-weld of all seams and lap seals.

3.3.4 Mechanically Fastened Membrane Application

Layout membrane and lap adjoining sheets in accordance with membrane manufacturer's printed instructions such that the minimum recommended seam width is maintained and to ensure that seam width is as required by tested assembly meeting specified wind resistance requirements. Account for additional overlap required for placement of fasteners and plates or battens beyond the closed seam. Allow for sufficient membrane to form proper membrane terminations. Ensure membrane is free of wrinkles and ridges in the installation. Mechanically secure the membrane sheet with specified fasteners in the lap area. Space fasteners as required to

provide the wind uplift resistance specified and in accordance with submitted fastener patterns for the field, corner, and perimeter roof areas. Set fasteners firm to plate or batten. Form field hot-air-welded seams, laps and coverstrips, as specified. Check all seams and ensure full/continuous lap seal.

3.3.5 Perimeter and High Wind Attachment

Adhesive bond and mechanically secure roof membrane sheet at roof perimeter and other areas in a manner to comply with wind resistance requirements and in accordance with membrane manufacturer's printed application instructions. When adhesively bonding a mechanically fastened system in perimeter areas, the perimeter boundary of the adhesive bond must be the same as the boundary required for additional perimeter mechanical fastening to meet wind resistance requirements.

3.3.6 Securement at Base Tie-In Conditions

Mechanically fasten the roof membrane at penetrations, at base of curbs and walls, and at all locations where the membrane turns and angles greater than 4 degrees (1:12). Space fasteners a maximum of 12 inches on center, except where more frequent attachment is required to meet specified wind resistance or where recommended by the roof membrane manufacturer. Cover over all exposed fasteners with a layer of roof manufacturer's flashing material. Hot-air-weld all seams of flashing material as recommended by the roof membrane manufacturer's printed data.

3.3.7 Pre-fabricated Curbs

Securely anchor prefabricated curbs to nailer or other base substrate and flashed with PVC membrane flashing materials.

3.3.7.1 Set-On Accessories

Where pipe or conduit blocking, supports and similar roof accessories, or isolated paver block, are set on the membrane, adhere reinforced membrane or walkpad material, as recommended by the roof membrane manufacturer, to bottom of accessories prior to setting on roofing membrane. Specific method of installing set-on accessories must permit normal movement due to expansion, contraction, vibration, and similar occurrences without damaging roofing membrane. Do not mechanically secure set-on accessories through roofing membrane into roof deck substrate.

3.4 FLASHINGS

Provide flashings in the angles formed at walls and other vertical surfaces and where required to make the work watertight, except where metal flashings are indicated.

3.4.1 General

Provide a one-ply flashing membrane, as specified for the system used, and install immediately after the roofing membrane is placed and prior to finish coating where a finish coating is required. Flashings must be stepped where vertical surfaces abut sloped roof surfaces. Provide sheet metal reglet in which sheet metal cap flashings are installed of not more than 16 inch nor less than 8 inch above the roofing surfaces. Exposed joints and end laps of flashing membrane must be made and sealed in the manner required for roofing membrane.

3.4.2 Membrane Flashing

3.4.2.1 Installation

Install flashing and flashing accessories as the roof membrane is installed. Apply flashing to cleaned surfaces and as recommended by the roof membrane manufacturer and as specified. Utilize cured PVC membrane flashing and prefabricated accessory flashings to the maximum extent recommended by the roof membrane manufacturer. Limit uncured flashing material to reinforcing inside and outside corners and angle changes in plane of membrane, and to flashing scuppers, pourable sealer pockets, and other formed penetrations or unusually shaped conditions as recommended by the roof membrane manufacturer where the use of cured material is impractical. Extend base flashing not less than 8 inch above roofing surface and as necessary to provide for seaming overlap on roof membrane as recommended by the roof membrane manufacturer.

3.4.2.2 Sealing

Seal flashing membrane for a minimum of 3 inch on each side of fastening device used to anchor roof membrane to nailers. Completely adhere flashing sheets in place. Seam flashing membrane in the same manner as roof membrane, except as otherwise recommended by the membrane manufacturer's printed instructions and approved by the Contracting Officer. Reinforce all corners and angle transitions by applying uncured membrane to the area in accordance with roof membrane manufacturer recommendations. Mechanically fasten top edge of base flashing with manufacturer recommended termination bar fastened at maximum 12 inch on center. Install sheet metal flashing over the termination bar in the completed work. Mechanically fasten top edge of base flashing for all other terminations in a manner recommended by the roof membrane manufacturer. Apply membrane liner over top of exposed nailers and blocking and to overlap top edge of base flashing installation at curbs, parapet walls, expansion joints and as otherwise indicated to serve as waterproof lining under sheet metal flashing components.

3.5 CORRECTION OF DEFICIENCES

Where any form of deficiency is found, take additional measures as deemed necessary by the Contracting Officer to determine the extent of the deficiency and provide corrective action recommendations. Perform corrective action as directed by the Contracting Officer.

3.6 PROTECTION OF APPLIED ROOFING

At the end of the day's work and when precipitation is imminent, protect applied membrane roofing system from water intrusion.

3.6.1 Water Cutoffs

Straighten insulation line using loose-laid cut insulation sheets and seal the terminated edge of the roof membrane system in an effective manner. Seal off flutes in metal decking along the cutoff edge. Remove the water cut-offs to expose the insulation when resuming work, and remove the insulation sheets used for fill-in.

3.6.2 Temporary Flashing for Permanent Roofing

Provide temporary flashing at drains, curbs, walls and other penetrations and terminations of roofing sheets until permanent flashings can be applied. Remove temporary flashing before applying permanent flashing.

3.6.3 Temporary Walkways, Runways, and Platforms

Do not permit storing, walking, wheeling, and trucking directly on applied roofing system. Provide temporary walkways, runways, and platforms of smooth clean boards, mats or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to live load limits of roof construction. Use rubber-tired equipment for roofing work.

3.7 FIELD QUALITY CONTROL

3.7.1 Construction Monitoring

During progress of the roof work, make visual inspections as necessary to ensure compliance with specified parameters. Additionally, verify the following:

a. Equipment is in working order. Metering devices are accurate.

b. Materials are not installed in adverse weather conditions.

c. Substrates are in acceptable condition, in compliance with specification, prior to application of subsequent materials.

(1) Nailers and blocking are provided where and as needed.

(2) Insulation substrate is smooth, properly secured to its substrate, and without excessive gaps prior to membrane application.

(3) The proper number, type, and spacing of fasteners are installed.

(4) Materials comply with the specified requirements.

(5) All materials are properly stored, handled and protected from moisture or other damages. Liquid components are properly mixed prior to application.

(6) Adhesives are applied uniformly to both mating surfaces and checked for proper set prior to bonding mating materials. Mechanical attachments are spaced as required, including additional fastening of membrane in corner and perimeter areas as required.

(7) Membrane is properly overlapped.

(8) Membrane seaming is as specified by PVC membrane manufacturer. All seams are checked at the end of each work day.

(9) Applied membrane is inspected and repaired as necessary prior to paver installation.

(10) Membrane is adhered without ridges, wrinkles, kinks, fishmouths.

(11) Installer adheres to specified and detailed application parameters.

(12) Associated flashing's and sheet metal are installed in a timely manner in accord with the specified requirements.

(13) Paver ballast is within the specified weight range.

(14) Temporary protection measures are in place at the end of each work shift.

3.8 CLEAN UP

Remove debris, scraps, containers and other rubbish and trash resulting from installation of the roofing system from job site each day.

3.9 INSTRUCTIONS TO GOVERNMENT PERSONNEL

Furnish written and verbal instructions on proper maintenance procedures to designated Government personnel. Verbal instructions must be provided by a competent representative of the roof membrane manufacturer and include a minimum of 4 hours on maintenance and emergency repair of the membrane. Include a demonstration of membrane repair, and give sources of required special tools. Furnish information on safety requirements during maintenance and emergency repair operations. Include copies of Safety Data Sheets for maintenance/repair materials.

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 60 00

FLASHING AND SHEET METAL

08/23

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SECTION 07 60 00

FLASHING AND SHEET METAL
08/23

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A480/A480M	(2023) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM B209/B209M	(2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films

ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free
ASTM E2112	(2023) Standard Practice for Installation of Exterior Windows, Doors and Skylights

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0429	(2022) The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control and Reroofing

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

SINGLE PLY ROOFING INDUSTRY (SPRI)

ANSI/SPRI/FM 4435/ES-1	(2017) Test Standard for Edge Systems Used with Low Slope Roofing Systems

1.2 GENERAL REQUIREMENTS

Finished sheet metal assemblies must form a weathertight enclosure without waves, warps, buckles, fastening stresses or distortion, while allowing for expansion and contraction without damage to the system. The sheet metal installer is responsible for cutting, fitting, drilling, and other operations in connection with sheet metal modifications required to accommodate the work of other trades. Coordinate installation of sheet metal items used in conjunction with roofing with roofing work to permit continuous, uninterrupted roofing operations.

1.2.1 General Material Requirements

All materials specified in this Section installed in conjunction with the roofing system must be provided by the roofing system manufacturer, or by a manufacturer approved by the roofing system manufacturer for use in the roofing system, and must form a part of the Warranty as required by the applicable roofing system Section.

1.2.2 Additional Wind Uplift Requirements

All flashing and edge materials specified in this Section must be installed in conjunction with the requirements of the roofing system to meet the requirements of ES-1 wind uplift. Details must include but not limited to ANSI/SPRI/FM 4435/ES-1 (ES-1), "Wind Test Design Standard for Edge Systems" used with Low Slope Roofing Systems, Test Methods: RE-1, RE-2 and RE-3 using uplift roofing details of the NRCA 0429.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL

PROCEDURES:

SD-02 Shop Drawings

Exposed Sheet Metal Coverings;

Gutters; G, DO

Downspouts; G, DO

Expansion Joints; G, DO

Counterflashing; G, DO

Reglets; G, DO

Drip Edges;

Eave Flashing; G, DO

Recycled Content;

SD-04 Samples

Finish Samples; G, DO

SD-05 Design Data

Wind Uplift Requirements; G, DO

SD-07 Certificates

Warranty on Finishes;

SD-08 Manufacturer's Instructions

Instructions for Installation;

Quality Control Plan;

SD-10 Operation and Maintenance Data

Cleaning and Maintenance;

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 MISCELLANEOUS REQUIREMENTS

1.4.1 Product Data

Indicate thicknesses, dimensions, fastenings, anchoring methods, expansion joints, and other provisions necessary for thermal expansion and contraction. Scaled manufacturer's catalog data may be submitted for factory fabricated items.

1.4.2 Finish Samples

Submit two color charts and two finish sample chips from manufacturer's standard color and finish options for each type of finish indicated.

1.4.3 Operation and Maintenance Data

Submit detailed instructions for installation and quality control during installation, cleaning and maintenance, for each type of assembly indicated.

1.5 DELIVERY, HANDLING, AND STORAGE

Package and protect materials during shipment. Uncrate and inspect materials for damage, dampness, and wet-storage stains upon delivery to the job site. Remove from the site and replace damaged materials that cannot be restored to like-new condition. Handle sheet metal items to avoid damage to surfaces, edges, and ends. Store materials in dry, weather-tight, ventilated areas until installation.

PART 2 PRODUCTS

2.1 RECYCLED CONTENT

Provide products with recycled content. Provide data for each product with recycled content, identifying percentage of recycled content.

2.2 MATERIALS

Use any metal listed by NRCA 0429 or SMACNA 1793 for a particular item, unless otherwise indicated. Provide materials and configurations in accordance with NRCA 0429 or SMACNA 1793 for each material, while also meeting the minimum thickness requirements specified in this Section. Different items need not be of the same metal, except that contact between dissimilar metals must be avoided.

Provide sheet metal items in 8 to 10 foot lengths. Single pieces less than 8 feet long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory fabricate corner pieces with minimum 12 inch legs. Provide accessories and other items essential to complete the sheet metal installation. Provide accessories made of the same or compatible materials as the items to which they are applied. Fabricate sheet metal items of the materials specified below and to the gage, thickness, or weight shown in Table I at the end of this section. Provide sheet metal items with mill finish unless specified otherwise. Where more than one material is listed for a particular item in Table I, each is acceptable and may be used, except as follows:

2.2.1 Exposed Sheet Metal Items

Provide exposed sheet metal items of the same material. Consider the following as exposed sheet metal: gutters, including hangers; downspouts; fascia; cap, valley, steeped, base, and eave flashings and related accessories.

2.2.2 Drainage

Do not use copper for an exposed item if drainage from that item will pass

over exposed concrete or other metal surfaces. In addition to the metals listed in Table I, lead-coated copper may be used for such items.

2.2.3 Steel Sheet, Aluminum Zinc-Coated

Provide in accordance with ASTM A792/A792M, a minimum of 24 gauge.

2.2.4 Stainless Steel

Provide in accordance with ASTM A480/A480M, Type 302 or 304, 2D Finish, fully annealed, dead-soft temper, a minimum of 24 gauge.

2.2.5 Aluminum Alloy Sheet and Plate

Provide in accordance with ASTM B209/B209M anodized color as indicated form alloy, and temper appropriate for use. Provide material not less than 0.065-in in thickness.

2.2.6 Finishes

Provide exposed exterior sheet metal and aluminum with a baked on, factory applied coil fluoropolymer color coating or approved equal siliconized polyester coating. Dry film thickness of coatings must be 0.8 to 1.3 mils. Color to be selected from manufacturer's full range of color choices as indicated on the Drawings. Field applications of color coatings are prohibited and will be rejected.

2.2.6.1 Warranty on Finishes

Provide a manufacturer's warranty to repair, or replace, sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within 20 years from date of project substantial completion. Deterioration includes the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.

b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.

c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2.2.7 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

ASTM B221.

2.2.8 Reglets

2.2.8.1 Polyvinyl Chloride Reglets

Provide in accordance with ASTM D1784, Type II, Grade 1, Class 14333-D, 0.075 inch minimum thickness.

2.2.8.2 Metal Reglets

Provide factory fabricated caulked type or friction type reglets with a minimum opening of 1/4 inch and a depth of 1-1/4 inch, as approved.

2.2.8.2.1 Caulked Reglets

Provide with rounded edges, temporary reinforcing cores, and accessories as required for securing to adjacent construction. Provide built-up mitered corner pieces for inside and outside corners.

2.2.8.2.2 Friction Reglets

Provide with flashing receiving slots not less than 5/8 inch deep, one inch jointing tongues, and upper and lower anchoring flanges installed at 24 inch maximum snap-lock type receiver.

2.2.9 Copings

Unless otherwise indicated, provide copings in copper sheets, 8 or 10 feet long, joined by a 3/4 inch locked and soldered seam.

2.2.10 Bituminous Plastic Cement

Provide in accordance with ASTM D4586/D4586M, Type I.

2.2.11 Roofing Felt

Provide in accordance with ASTM D226/D226M Type II.

2.2.12 Asphalt Primer

Provide in accordance with ASTM D41/D41M.

2.2.13 Fasteners

Use the same metal as, or a metal compatible with the item fastened. Confirm compatibility of fasteners and items to be fastened to avoid galvanic corrosion due to dissimilar materials.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Workmanship

Make lines and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793, Architectural Sheet Metal Manual. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight. Join sheet metal items together as shown in Table II.

3.1.2 Nailing

Confine nailing of sheet metal generally to sheet metal having a maximum width of 18 inches. Confine nailing of flashing to one edge only. Space

nails evenly not over 3 inch on center and approximately 1/2 inch from edge unless otherwise specified or indicated. Face nailing is not permitted. Where sheet metal is applied to other than wood surfaces, include in shop drawings, the locations for sleepers and nailing strips required to secure the work. Secure flashing at one-half the normal interval to ensure a wind-resistant installation.

3.1.3 Cleats

Provide cleats for sheet metal 18 inches and over in width. Space cleats evenly not over 12 inches on center unless otherwise specified or indicated. Unless otherwise specified, provide cleats of 2 inches wide by 3 inches long and of the same material and thickness as the sheet metal being installed. Secure one end of the cleat with two nails and the cleat folded back over the nailheads. Lock the other end into the seam. Where the fastening is to be made to concrete, use screws and drive in expansion shields set in concrete. Pre-tin cleats for soldered seams.

3.1.4 Bolts, Rivets, and Screws

Install bolts, rivets, and screws where indicated or required. Provide compatible washers where required to protect surface of sheet metal and to provide a watertight connection. Provide mechanically formed joints in aluminum sheets 0.040 inches or less in thickness.

3.1.5 Seams

Straight and uniform in width and height with no solder showing on the face.

3.1.5.1 Flat-lock Seams

Finish not less than 3/4 inch wide.

3.1.5.2 Lap Seams

Finish soldered seams not less than one inch wide. Overlap seams not soldered, not less than 3 inches.

3.1.5.3 Loose-Lock Expansion Seams

Not less than 3 inches wide; provide minimum one inch movement within the joint. Completely fill the joints with the specified sealant, applied at not less than 1/8 inch thick bed.

3.1.5.4 Standing Seams

Not less than one inch high, double locked without solder.

3.1.5.5 Flat Seams

Make seams in the direction of the flow.

3.1.6 Soldering

Where soldering is specified, apply to copper, terne-coated stainless steel, zinc-coated steel, and stainless steel items. Pre-tin edges of sheet metal before soldering is begun. Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder

aluminum.

3.1.6.1 Edges

Scrape or wire-brush the edges of lead-coated material to be soldered to produce a bright surface. Flux brush the seams in before soldering. Treat with soldering acid flux the edges of stainless steel to be pre-tinned. Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

3.1.7 Welding and Mechanical Fastening

Use welding for aluminum of thickness greater than 0.040 inch. Aluminum 0.040 inch or less in thickness must be butted and the space backed with formed flashing plate; or lock joined, mechanically fastened, and filled with sealant as recommended by the aluminum manufacturer.

3.1.7.1 Welding of Aluminum

Use welding of the inert gas, shield-arc type. For procedures, appearance and quality of welds, and the methods used in correcting welding work, conform to AWS D1.2/D1.2M.

3.1.7.2 Mechanical Fastening of Aluminum

Use No. 12, aluminum alloy, sheet metal screws or other suitable aluminum alloy or stainless steel fasteners. Drive fasteners in holes made with a No. 26 drill in securing side laps, end laps, and flashings. Space fasteners 12 inches maximum on center. Where end lap fasteners are required to improve closure, locate the end lap fasteners not more than 2 inches from the end of the overlapping sheet.

3.1.8 Protection from Contact with Dissimilar Materials

3.1.8.1 Copper or Copper-bearing Alloys

Paint with heavy-bodied bituminous paint surfaces in contact with dissimilar metal, or separate the surfaces by means of moistureproof building felts.

3.1.8.2 Aluminum

Do not allow aluminum surfaces in direct contact with other metals except stainless steel, zinc, or zinc coating. Where aluminum contacts another metal, paint the dissimilar metal with a primer followed by two coats of aluminum paint. Where drainage from a dissimilar metal passes over aluminum, paint the dissimilar metal with a non-lead pigmented paint. Aluminum may be used over concrete construction, provided that required reglets are of stainless steel and aluminum surface in contact with concrete is coated with bituminous paint or zinc chromate primer.

3.1.8.3 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.8.4 Wood or Other Absorptive Materials

Paint surfaces that may become repeatedly wet and in contact with metal

with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

3.1.9 Expansion and Contraction

Provide expansion and contraction joints at not more than 32 foot intervals for aluminum and at not more than 40 foot intervals for other metals. Provide an additional joint where the distance between the last expansion joint and the end of the continuous run is more than half the required interval. Space joints evenly. Join extruded aluminum gravel stops and fascia by expansion and contraction joints spaced not more than 12 feet apart.

3.1.10 Counterflashing

Except where indicated or specified otherwise, insert counterflashing in reglets located from 9 to 10 inches above roof decks, extend down vertical surfaces over upturned vertical leg of base flashings not less than 3 inches. Fold the exposed edges of counterflashings 1/2 inch. Where stepped counterflashings are required, they may be installed in short lengths a minimum 8 inches by 8 inches or may be of the preformed single piece type. Provide end laps in counterflashings not less than 3 inches and make it weathertight with plastic cement. Do not make lengths of metal counterflashings exceed 10 feet. Form flashings to the required shapes before installation. Factory form corners not less than 12 inches from the angle. Secure the flashings in the reglets with lead wedges and space not more than 18 inches apart; on short runs, place wedges closer together. Fill caulked-type reglets or raked joints which receive counterflashing with caulking compound. Turn up the concealed edge of counterflashings built into concrete walls not less than 1/4 inch and extend not less than 2 inches into the walls. Install counterflashing to provide a spring action against base flashing. Where bituminous base flashings are provided, extend down the counter flashing as close as practicable to the top of the cant strip. Factory form counter flashing to provide spring action against the base flashing.

3.1.11 Metal Reglets

Keep temporary cores in place during installation. Ensure factory fabricated caulked type or friction type, reglets have a minimum opening of 1/4 inch and a minimum depth of 1-1/4 inch, when installed.

3.1.11.1 Caulked Reglets

Wedge flashing in reglets with lead wedges every 18 inches, caulked full and solid with an approved compound.

3.1.11.2 Friction Reglets

Install flashing snap lock receivers at 24 inches on center maximum. When flashing has been inserted the full depth of the slot, caulk the slot, lock with wedges, and fill with sealant.

3.1.12 Polyvinyl Chloride Reglets for Temporary Construction

Rigid polyvinyl chloride reglets may be provided in lieu of metal reglets for temporary construction.

3.1.13 Metal Drip Edges

Provide a metal drip edge, designed to allow water run-off to drip free of underlying construction, at eaves and rakes prior to the application of roofing shingles. Apply directly on the wood deck at the eaves and over the underlay along the rakes. Extend back from the edge of the deck not more than 3 inches and secure with compatible nails spaced not more than 10 inches on center along upper edge.

3.1.14 Gutters

The hung type of shape indicated and supported on underside by brackets that permit free thermal movement of the gutter. Provide gutters in sizes indicated complete with mitered corners, end caps, outlets, brackets, and other accessories necessary for installation. Bead with hemmed edge or reinforce the outer edge of gutter with a stiffening bar not less than 3/4 by 3/16 inch of material compatible with gutter. Fabricate gutters in sections not less than 8 feet. Lap the sections a minimum of one inch in the direction of flow or provide with concealed splice plate 6 inches minimum. Join the gutters, other than aluminum, by riveted and soldered joints. Join aluminum gutters with riveted sealed joints. Provide expansion-type slip joints midway between outlets. Install gutters below slope line of the roof so that snow and ice can slide clear. Support gutters on adjustable hangers spaced not more than 30 inches on center. Adjust gutters to slope uniformly to outlets, with high points occurring midway between outlets. Fabricate hangers and fastenings from compatible metals.

3.1.15 Downspouts

Space supports for downspouts according to the manufacturer's recommendation for the concrete or steel substrate. Types, shapes and sizes are indicated. Provide complete including elbows and offsets. Provide downspouts in approximately 10 foot lengths. Provide end joints to telescope not less than 1/2 inch and lock longitudinal joints. Provide gutter outlets with wire ball strainers for each outlet. Provide strainers to fit tightly into outlets and be of the same material used for gutters. Keep downspouts not less than one inch away from walls. Fasten to the walls at top, bottom, and at an intermediate point not to exceed 5 feet on center with leader straps or concealed rack-and-pin type fasteners. Form straps and fasteners of metal compatible with the downspouts.

3.1.15.1 Terminations

Neatly fit into the drainage connection the downspouts terminating in drainage lines and fill the joints with a portland cement mortar cap sloped away from the downspout. Provide downspouts terminating in splash blocks with elbow-type fittings. Provide splash pans as specified.

3.1.16 Eave Flashing

One piece in width, applied in 8 to 10 foot lengths with expansion joints spaced as specified in paragraph EXPANSION AND CONTRACTION. Provide a 3/4 inch continuous fold in the upper edge of the sheet to engage cleats spaced not more than 10 inches on center. Locate the upper edge of flashing not less than 18 inches from the outside face of the building, measured along the roof slope. Fold lower edge of the flashing over and loose-lock into a continuous edge strip on the fascia. Where eave

flashing intersects metal valley flashing, secure with one inch flat locked joints with cleats that are 10 inches on center.

3.1.17 Flashing at Wall Openings

Install pan flashing in the rough opening sill at all penetrations in the exterior wall assemblies, such as windows, louvers, storefronts and curtain walls. Pan sill flashing must have end dams at both jambs a minimum of 2 in high and a rear dam of 2 in high. Flashing must comply with ASTM E2112 and SMACNA 1793.

3.1.18 Sheet Metal Covering on Flat, Sloped, or Curved Surfaces

Except as specified or indicated otherwise, cover and flash all minor flat, sloped, or curved surfaces such as crickets, bulkheads, dormers and small decks with metal sheets of the material used for flashing; maximum size of sheets, 16 by 18 inches. Fasten sheets to sheathing with metal cleats. Lock seams and solder. Lock aluminum seams as recommended by aluminum manufacturer. Provide an underlayment of roofing felt for all sheet metal covering.

3.1.19 Expansion Joints

Provide expansion joints for roofs, walls, and floors as specified. Provide expansion joints in continuous sheet metal at 40 foot intervals for copper and stainless steel and at 32 foot intervals for aluminum,. Provide evenly spaced joints. Provide an additional joint where the distance between the last expansion joint and the end of the continuous run is more than half the required interval spacing. Conform to the requirements of Table I.

3.1.19.1 Roof Expansion Joints

Consist of curb with wood nailing members on each side of joint, bituminous base flashing, metal counterflashing, and metal joint cover. Bituminous base flashing is specified in Roofing Section. Provide counterflashing as specified in paragraph COUNTERFLASHING, except as follows: Provide counterflashing with vertical leg of suitable depth to enable forming into a horizontal continuous cleat. Secure the inner edge to the nailing member. Make the outer edge projection not less than one inch for flashing on one side of the expansion joint and be less than the width of the expansion joint plus one inch for flashing on the other side of the joint. Hook the expansion joint cover over the projecting outer edges of counterflashing. Provide roof joint with a joint cover of the width indicated. Hook and lock one edge of the joint cover over the shorter projecting flange of the continuous cleat, and the other edge hooked over and loose locked with the longer projecting flange. Joints are specified in Table II.

3.1.19.2 Floor and Wall Expansion Joints

Provide U-shape with extended flanges for expansion joints in concrete walls and in floor slabs.

3.1.20 Single Pipe Vents

See Table I, footnote (d). Set flange of sleeve in bituminous plastic cement and nail 3 inches on center. Bend the top of sleeve over and extend down into the vent pipe a minimum of 2 inches. For long runs or

long rises above the deck, where it is impractical to cover the vent pipe with lead, use a two-piece formed metal housing. Set metal housing with a metal sleeve having a 4 inches roof flange in bituminous plastic cement and nailed 3 inches on center. Extend sleeve a minimum of 8 inches above the roof deck and lapped a minimum of 3 inches by a metal hood secured to the vent pipe by a draw band. Seal the area of hood in contact with vent pipe with an approved sealant.

3.1.21 Stepped Flashing

Provide stepped flashing where sloping roofs surfaced with shingles abut vertical surfaces. Place separate pieces of base flashing in alternate shingle courses.

3.1.22 Through Wall Flashing

Provide through wall flashing as required in the applicable wall system Sections.

3.2 PAINTING

Touch ups in the field may be applied only after metal substrates have been cleaned and pretreated in accordance with manufacturer's written instructions and products.

Field-paint dissimilar sheet metals in contact to separate and deter galvanic interactions.

3.2.1 Aluminum Surfaces

Clean with solvent and apply one coat of zinc-molybdate primer and one coat of aluminum paint.

3.3 CLEANING

Clean exposed sheet metal work at completion of installation. Remove grease and oil films, handling marks, contamination from steel wool, fittings and drilling debris, and scrub-clean. Free the exposed metal surfaces of dents, creases, waves, scratch marks, and solder or weld marks.

3.4 REPAIRS TO FINISH

Scratches, abrasions, and minor surface defects of finish may be repaired in accordance with the manufacturer's printed instructions and as approved. Repair damaged surfaces caused by scratches, blemishes, and variations of color and surface texture. Replace items which cannot be repaired.

3.5 FIELD QUALITY CONTROL

Establish and maintain a Quality Control Plan for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the Contract requirements. Remove work that is not in compliance with the Contract and replace or correct. Include quality control, but not be limited to, the following:

a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.

b. Verification that specified material is provided and installed.

c. Inspection of sheet metalwork, for proper size(s) and thickness(es), fastening and joining, and proper installation.

3.5.1 Procedure

Submit for approval prior to start of roofing work. Include a checklist of points to be observed. Document the actual quality control observations and inspections. Provide a copy of the documentation to the Contracting Officer at the end of each day.

HL4>TABLE I. SHEET METAL WEIGHT, THICKNESSES, AND GAGES

Sheet Metal Items	Copper kilograms per square foot	Aluminum, inch	Stainless Steel, inch	Terne-Coated Stainless Steel, inch	Zinc-Coated Steel, U.S. Std. Gage
Building Expansion Joints					
Cover	16	.032	.015	.015	24
Waterstop-bellows or flanged, U-type.	16	-	.015	.015	-
Covering on minor flat, pitched or curved surfaces	20	.040	.018	.018	-
Downspouts and leaders	16	.032	.015	.015	24
Downspout clips and anchors	-	.040 clip .125 anchor	-	-	-
Downspout straps, 2-inch	48 (a)	.060	.050	-	-
Conductor heads	16	.032	.015	.015	-
Scupper lining	20	.032	.015	.015	-
Strainers, wire diameter or gage	No. 9 gage	.144 diameter	.109 diameter	-	
Flashings:					
Base	20	.040	.018	.018	24

HL4>TABLE I. SHEET METAL WEIGHT, THICKNESSES, AND GAGES

Sheet Metal Items	Copper kilograms per square foot	Aluminum, inch	Stainless Steel, inch	Terne-Coated Stainless Steel, inch	Zinc-Coated Steel, U.S. Std. Gage
Cap (Counter-flashing)	16	.032	.015	.015	26
Eave	16	-	.015	.015	24
Spandrel beam	10	-	.010	.010	-
Bond barrier	16	-	.015	.015	-
Stepped	16	.032	.015	.015	-
Valley	16	.032	.015	.015	-
Roof drain	16 (b)				
Pipe vent sleave (d)					
Coping	16	-	-	-	-
Gravel stops and fascia:					
Extrusions	-	.075	-	-	-
Sheets, corrugated	16	.032	.015	.015	-
Sheets, smooth	20	.050	.018	.018	24
Edge strip	24	.050	.025	-	-
Gutters:					
Gutter section	16	.032	.015	.015	24
Continuous cleat	16	.032	.015	.015	24
Hangers, dimensions	1 inch by 1/8 inch (a)	1 inch by .(inch (c)	1 inch by .0 inch	-	-
Joint Cover plates (See Table II)	16	.032	.015	.015	24
Reglets (c)	10	-	.010	.010	-
Splash pans	16	.040	.018	.018	-
(a) Brass.					

HL4>TABLE I. SHEET METAL WEIGHT, THICKNESSES, AND GAGES

Sheet Metal Items	Copper kilograms per square foot	Aluminum, inch	Stainless Steel, inch	Terne-Coated Stainless Steel, inch	Zinc-Coated Steel, U.S. Std. Gage
(b) May be lead weighing 4 pounds per square foot.					
(c) May be polyvinyl chloride.					
(d) 2.5 pound minimum lead sleeve with 4 inch flange. Where lead sleeve is impractical, refer to paragraph SINGLE PIPE VENTS for optional material.					

TABLE II. SHEET METAL JOINTS

	TYPE OF JOINT		
Item Designation	Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel	Aluminum	Remarks
Joint cap for building expansion seam, cleated joint at roof	1.25 inch single lock, standing seam, cleated	1.25 inch single lock, standing	--
Flashings			
Base	One inch 3 inch lap for expansion joint	One inch flat locked, soldered; sealed; 3 inch lap for expansion joint	Aluminum manufacturer's recommended hard setting sealant for locked aluminum joints. Fill each metal expansion joint with a joint sealing compound.
Cap-in reglet	3 inch lap	3 inch lap	Seal groove with joint sealing compound.

TABLE II. SHEET METAL JOINTS			
	TYPE OF JOINT		
Item Designation	Copper, Terne-Coated Stainless Steel, Zinc-Coated Steel and Stainless Steel	Aluminum	Remarks
Reglets	Butt joint	--	Seal reglet groove with joint sealing compound.
Eave	One inch flat locked, cleated. One inch loose locked, sealed expansion joint, cleated.	One inch flat locked, locked, cleated one inch loose locked, sealed expansion joints, cleated	Same as base flashing.
Stepped	3 inch lap	3 inch lap	--
Valley	6 inch lap cleated	6 inch lap cleated	--
Edge strip	Butt	Butt	--
Gravel stops:			
Extrusions	--	Butt with 1/2 inch space	Use sheet flashing beneath and a cover plate
Sheet, smooth	Butt with 1/4 inch space	Butt with 1/4 inch space	Use sheet flashing backup plate.
Sheet, corrugated	Butt with 1/4 inch space	Butt with 1/4 inch space	Use sheet flashing beneath and a cover plate or a combination unit
Gutters	1.5 inch lap, riveted and soldered	One inch flat locked riveted and sealed	Aluminum producers recommended hard setting sealant for locked aluminum joints.
(a) Provide a 3 inch lap elastomeric flashing with manufacturer's recommended sealant.			
(b) Seal Polyvinyl chloride reglet with manufacturer's recommended sealant.			

-- End of Section --

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 61 14.00 20

STEEL STANDING SEAM ROOFING

08/16, CHG 1: 08/18

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STEEL STANDING SEAM ROOFING
08/16, CHG 1: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A792/A792M	(2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D522/D522M	(2017) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2014; R 2018) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2017) Standard Test Method for Evaluating Degree of Blistering of Paints
ASTM D968	(2017) Standard Test Methods for Abrasion

	Resistance of Organic Coatings by Falling Abrasive
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D2244	(2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2247	(2015) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D4214	(2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films
ASTM E1592	(2017) Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM G152	(2013; R 2021) Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2013; R 2021) Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

1.2 DEFINITIONS

1.2.1 Field-Formed Seam

Seams of panels so configured that when adjacent sheets are installed the seam is sealed utilizing mechanical or hand seamers. Crimped (45 degree bend), roll formed (180 degree bend), double roll formed (2 - 180 degree bends), and roll and lock systems are types of field-formed seam systems.

1.2.2 Snap Together Seam

Panels so configured that the male and female portions of the seam interlock through the application of foot pressure or tamping with a mallet. Snap-on cap configurations are a type of snap together system.

1.2.3 Pre-Formed

Formed to the final, less field-formed seam, profile and configuration in

the factory.

1.2.4 Field-Formed

Formed to the final, less field-formed seam, profile and configuration at the site of work prior to installation.

1.2.5 Roofing System

The roofing system is defined as the assembly of roofing components, including roofing panels, flashing, fasteners, snow guards assembly, and accessories which, when assembled properly result in a watertight installation.

1.2.6 SSMRS

Standing Seam Metal Roof System (SSMRS) is abbreviation of the entire roof system specified herein with all components and parts coming from a single manufacturer's system.

1.3 SYSTEM DESCRIPTION

1.3.1 Design Requirements

a. Panels must be continuous lengths up to manufacturer's standard longest lengths, with no joints or seams, except where indicated or specified. Ribs of adjoining sheets must be in continuous contact from eave to ridge. Individual panels of snap together type systems must be removable for replacement of damaged material.

b. There must be no exposed or penetrating fasteners except where shown on approved shop drawings. Fasteners into steel must be stainless steel, zinc cast head, or cadmium plated steel screws inserted into predrilled holes. There must be a minimum of two fasteners per clip. Single fasteners will be allowed when supporting structural members are prepunched or predrilled.

c. Snap together type systems must have a capillary break and a positive side lap locking device. Field-formed seam type systems must be mechanically locked closed by the manufacturer's locking tool. The seam must include a continuous factory applied sealant when required by the manufacturer to withstand the wind loads specified.

d. Roof panel anchor clips must be concealed and designed to allow for longitudinal thermal movement of the panels, except where specific fixed points are indicated. Provide for lateral thermal movement in panel configuration or with clips designed for lateral and longitudinal movement.

1.3.2 Design Conditions

Design the system to resist positive and negative loads specified herein in accordance with the AISI SG03-3. Panels must support walking loads without permanent distortion or telegraphing of the structural supports.

1.3.2.1 Wind Uplift

The design uplift pressures shall be in accordance with sheet S-005. The design uplift force for each connection assembly must be that pressure

given for the area under consideration, multiplied by the tributary load area of the connection assembly, and multiplied by the appropriate factor of safety, as follows:

a. Single fastener in a connection: 3.0

b. Two or more fasteners in each connection: 2.25

1.3.2.2 Roof Live Loads

Loads must be applied on the horizontal projection of the roof structure. The minimum roof design live loadshall be as indicated on the contract drawings.

1.3.2.3 Thermal Movement

System must be capable of withstanding thermal movement based on a temperature range of 10 degrees F below 0 degrees F and 180 degrees F.

1.3.2.4 Deflection

Panels must be capable of supporting design loads between unsupported spans with deflection of not greater than L/180 of the span.

1.3.3 Structural Performance

The structural performance test methods and requirements of the Standing Seam Roofing Systems (SSRS) must be in accordance with ASTM E1592.

1.3.4 Snow Guards

A snow retention/guard system is required at locations indicated on Roof Plan. Snow guard system shall be designed to resist the vector forces resulting from the design roof snow loads. Calculate frequency of devices by using tested ultimate holding values for the device and a factor of safety of 2.0.

Contractor submittals are to include snow guard system frequency calculations specific to the product being submitted and documentation from an independent laboratory indicating holding strength of the device. Snow loads and loads imposed on the SSSMR by the snow guards shall be coordinated between the snow guard manufacturer and the standing seam metal roof manufacturer. Standing seam metal roofing, retention clips, subpurlins, and connections to structure shall be designed for the loads imposed on the roofing system by the snow guards.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roofing; G, DO

SD-03 Product Data

Roofing Panels; G, DO

Recycled Content for Steel Roofing Product;

Attachment Clips

Fasteners

Sealants

Sample Warranty Certificate; G, RO

Submit for materials to be provided. Submit data sufficient to indicate conformance to specified requirements.

Snow Guards

SD-04 Samples

Roofing Panel; G, RO

For color selection, submit 2 by 4 inch metal samples in color, finish and texture specified.

SD-05 Design Data

Design Calculations; G, DO

SD-06 Test Reports

Field Inspection; G, RO

Submit manufacturer's technical representative's field inspection reports as specified in paragraph MANUFACTURER'S FIELD INSPECTION.

Structural Performance Tests

Finish Tests

SD-07 Certificates

Manufacturer's Technical Representative's Qualifications

Statement of Installer's Qualifications

Submit documentation from roofing manufacturer proving the manufacturer's technical representative meets below specified requirements. Include name, address, telephone number, and experience record.

Submit documentation proving the installer is factory-trained, has the specified experience, and authorized by the manufacturer to install the products specified.

SD-08 Manufacturer's Instructions

Installation Manual;

Submit manufacturers printed installation manual, instructions, and standard details.

SD-11 Closeout Submittals

Warranty

1.5 DESIGN CALCULATIONS

Provide design calculations prepared by a professional engineer specializing in structural engineering verifying that system supplied and any additional framing meets design load criteria indicated. Coordinate calculations with manufacturer's test results. Include calculations for:

Wind load uplift design pressure at roof locations specified in paragraph WIND UPLIFT.

Clip spacing and allowable load per clip.

Fastening of clips to structure or intermediate supports.

Intermediate support spacing and framing and fastening to structure when required.

Allowable panel span at anchorage spacing indicated.

Safety factor used in design loading.

Governing code requirements or criteria.

Edge and termination details.

1.6 QUALITY ASSURANCE

1.6.1 Preroofing Conference

After submittals are received and approved but before roofing and insulation work, including associated work, is preformed, the Contractor must hold a preroofing conference to review the following:

a. The drawings and specifications

b. Procedure for on site inspection and acceptance of the roofing substrate and pertinent structural details relating to the roofing system

c. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing

d. Safety requirements

The preroofing conference must be attended by the Contractor and personnel directly responsible for the roofing and insulation installation, mechanical and electrical work, and the roofing manufacturer's technical representative. Conflicts among those attending the preroofing conference must be resolved and confirmed in writing before roofing work, including

associated work, is begun. Prepare written minutes of the preroofing conference and submit to the Contracting Officer.

1.6.2 Manufacturer

The SSMRS must be the product of a metal roofing industry - recognized manufacturer who has been in the practice of manufacturing SSMRS for a period of not less than 5 years and who has been involved in at least 5 projects similar in size and complexity to this project.

1.6.3 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products and with installations in the geographical area where construction will take place. The manufacturer's representative must be an employee of the manufacturer with at least 5 years experience in installing the roof system. The representative must be available to perform field inspections and attend meetings as required herein, and as requested by the Contracting Officer.

1.6.4 Installer's Qualifications

The roofing system installer must be factory-trained, approved by the steel roofing system manufacturer to install the system, and must have a minimum of three years experience as an approved applicator with that manufacturer. The applicator must have applied five installations of similar size and scope as this project within the previous 3 years.

1.6.5 Single Source

Roofing panels, clips, closures, and other accessories must be standard products of the same manufacturer; must be the latest design by the manufacturer; and must have been designed by the manufacturer to operate as a complete system for the intended use.

1.6.6 Laboratory Tests For Panel Finish

The term "appearance of base metal" refers to the metal coating on steel. Panels must meet the following test requirements:

a. Formability Test: When subjected to a 180 degree bend over a 1/8 inch diameter mandrel in accordance with ASTM D522/D522M, exterior coating film may show only slight microchecking and no loss of adhesion.

b. Accelerated Weathering Test: Withstand a weathering test for a minimum of 2000 hours in accordance with ASTM G152 and ASTM G153, Method 1 without cracking, peeling, blistering, loss of adhesion of the protective coating, or corrosion of the base metal. Protective coating that can be readily removed from the base metal with a penknife blade or similar instrument will be considered to indicate loss of adhesion.

c. Chalking Resistance: After the 2000-hour weatherometer test, exterior coating may not chalk greater than No. 8 rating when measured in accordance with ASTM D4214 test procedures.

d. Color Change Test:

After the 3000-hour weatherometer test, exterior coating color change must not exceed 5 NBS units when measured in accordance with ASTM D2244 test procedure.

e. Salt Spray Test: Withstand a salt spray test for a minimum of 1000 hours in accordance with ASTM B117, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating must receive a rating of 10, no blisters in field as determined by ASTM D714; and an average rating of 7, 1/16 inch failure at scribe, as determined by ASTM D1654. Rating Schedule No. 1.

f. Abrasion Resistance Test for Color Coating: When subjected to the falling sand test in accordance with ASTM D968, coating system must withstand a minimum of 50 liters of sand per mil thickness before appearance of base metal.

g. Humidity Test: When subjected to a humidity cabinet test in accordance with ASTM D2247 for 1000 hours, a scored panel must show no signs of blistering, cracking, creepage, or corrosion.

h. Gloss Test: The gloss of the finish must be 30 plus or minus 5 at an angle of 60 degrees, when measured in accordance with ASTM D523.

i. Glare Resistance Test:

Surfaces of panels that will be exposed to the exterior must have a specular reflectance of not more than 10 when measured in accordance with ASTM D523 at an angle of 85 degrees. Specular reflectance may be obtained with striations or embossing. Requirements specified under FORMABILITY TEST will be waived if necessary to conform to this requirement.

1.6.7 Shop Drawing Requirements

Submit roofing drawings to supplement the instructions and diagrams. Include design and erection drawings containing an isometric view of the roof showing the design uplift pressures and dimensions of edge, ridge and corner zones; and show typical and special conditions including flashings, materials and thickness, dimensions, fixing lines, anchoring methods, sealant locations, sealant tape locations, fastener layout, sizes, and spacing, terminations, penetrations, attachments, and provisions for thermal movement. Details of installation must be in accordance with the manufacturer's Standard Instructions and details or the SMACNA 1793. Prior to submitting shop drawings, have drawings reviewed and approved by the manufacturer's technical engineering department.

1.7 WARRANTY

Furnish manufacturer's no-dollar-limit materials and workmanship warranty for the roofing system. The warranty period must be not less than 20 years from the date of Government acceptance of the work. The warranty must be issued directly to the Government. The warranty must provide that if within the warranty period the metal roofing system becomes non-watertight or shows evidence of corrosion, perforation, rupture or excess weathering due to deterioration of the roofing system resulting from defective materials or installed workmanship the repair or replacement of the defective materials and correction of the defective workmanship must be the responsibility of the roofing system manufacturer. Repairs that become necessary because of defective

materials and workmanship while roofing is under warranty must be performed within 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time will constitute grounds for having the repairs performed by others and the cost billed to the manufacturer. In addition, provide a 2 year contractor installation warranty.

1.8 DELIVERY, STORAGE AND HANDLING

Deliver, store, and handle preformed panels, bulk roofing products and other manufactured items in a manner to prevent damage or deformation.

1.8.1 Delivery

Provide adequate packaging to protect materials during shipment. Crated materials must not be uncrated until ready for use, except for inspection. Immediately upon arrival of materials at the jobsite, inspect materials for damage, dampness, and staining. Replace damaged or permanently stained materials that cannot be restored to like-new condition with satisfactory material. If materials are wet, remove the moisture and re-stack and protect the panels until used.

1.8.2 Storage

Stack materials on platforms or pallets and cover with tarpaulins or other suitable weathertight covering which prevents water trapping or condensation. Store materials so that water which might have accumulated during transit or storage will drain off. Do not store the panels in contact with materials that might cause staining, such as mud, lime, cement, fresh concrete or chemicals. Protect stored panels from wind damage.

1.8.3 Handling

Handle material carefully to avoid damage to surfaces, edges and ends.

PART 2 PRODUCTS

2.1 ROOFING PANELS

Provide panels with interlocking ribs for securing adjacent sheets and with concealed clip fastening system for securing the roof covering to structural framing members. Fasteners must not penetrate the panels except at the ridge, eave, rakes, penetrations, and end laps. Backing plates and ends of panels at end laps must be predrilled or prepunched. Factory prepare ends of panels to be lapped by trimming part of seam, die-setting, or swaging ends of panels. Individual sheets must be sufficiently long to cover the entire length of any unbroken roof slope when such slope is 30 feet or less. Provide panels that extend over two or more spans when length of run exceeds 30 feet. Obtain Contracting Officer (KO) approval for sheets longer than 30 feet before submitting shop drawings. Sheets must provide not less than 12 inches of coverage (width) in place. Provide panels with a minimum corrugation height of 2.25 inches (nominal). Make provisions for expansion and contraction at either ridge or eave, consistent with the type of system to be used. Form panels from coil stockwithout warping, waviness or ripples not part of the panel profile, and free of damage to the finish coating system.

2.1.1 Material

Zinc-coated steel conforming to ASTM A653/A653M, G90 coating designation or aluminum-zinc alloy coated steel conforming to ASTM A792/A792M, AZ 55 coating. Provide material with a minimum thickness of 0.023 inch thick (24 gage) minimum except when mid field of roof is subject to design wind uplift pressures of 60 psf or greater, entire roof system must have a minimum thickness of 0.030 inch (22 gage). Steel roofing materials must contain a minimum of 30 percent total recycled content. Provide data identifying percentage of recycled content for steel roofing product. Prior to shipment, treat mill finish panels with a passivating chemical and oil to inhibit the formation of oxide corrosion products. Dry, retreat, and re-oil panels that have become wet during shipment or storage but have not started to oxidize.

2.1.2 Texture

Smooth with raised intermediate ribs for added stiffness.

2.1.3 Finish

Factory color finish. Color shall be as specified in the Color Notes on the drawings. Color listed is not intended to limit the selection of equal colors from other manufacturers..

2.1.3.1 Factory Color Finish

Provide factory applied, thermally cured coating to exterior and interior of metal roof and wall panels and metal accessories. Provide exterior finish top coat of 70 percent resin polyvinylidene fluoride with not less than 0.8 mil dry film thickness. Provide exterior primer standard with panel manufacturer with not less than 0.2 mil dry film thickness. Interior finish must consist of 0.5 mil dry film thickness backer coat. Provide exterior coating meeting test requirements specified below. Tests must have been performed on the same factory finish and thickness provided. Provide clear factory edge coating on all factory cut or unfinished edges.

2.2 INTERMEDIATE SUPPORTS

Fabricate panel subgirts, subpurlins, T-bars, Z-bars and tracks from galvanized steel conforming to ASTM A653/A653M, G90, Grade D (16 gage and heavier), Grade A (18 gage and lighter); or steel conforming to ASTM A36/A36M, ASTM A1011/A1011M , or ASTM A1008/A1008M prime painted with zinc-rich primer. Size, shape, thickness and capacity as required to meet the load, insulation thickness and deflection criteria specified.

2.3 ATTACHMENT CLIPS

Fabricate clips from ASTM A1011/A1011M, or ASTM A1008/A1008M steel hot-dip galvanized in accordance with ASTM A653/A653M, G 90, or Series 300 stainless steel. Size, shape, thickness and capacity as required to meet the load, insulation thickness and deflection criteria specified.

2.4 ACCESSORIES

Sheet metal flashings, trim, moldings, closure strips, caps, and other similar sheet metal accessories used in conjunction with preformed metal panels must be of the same material as used for the panels. Provide metal

accessories with a factory color finish to match the roofing panels, except that such items which will be concealed after installation may be provided without the finish if they are stainless steel. Metal must be of a thickness not less than that used for the panels.

2.4.1 Fasteners

Zinc-coated steel, corrosion resisting steel, zinc cast head, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Design the fastening system to withstand the design loads specified. Exposed fasteners must be gasketed or have gasketed washers on the exterior side of the covering to waterproof the penetration. Washer material must be compatible with the covering; have a minimum diameter of 3/8 inch for structural connections; and gasketed portion of fasteners or washers must be neoprene or other equally durable elastomeric material approximately 1/8 inch thick.

2.4.1.1 Screws

Not smaller than No. 14 diameter if self-tapping type and not smaller than No. 12 diameter if self-drilling and self-tapping.

2.4.1.2 Bolts

Not smaller than 1/4 inch diameter, shouldered or plain shank as required, with proper nuts.

2.4.1.3 Automatic End-Welded Studs

Automatic end-welded studs must be shouldered type with a shank diameter of not smaller than 3/16 inch and cap or nut for holding covering against the shoulder.

2.4.1.4 Explosive Driven Fasteners

Fasteners for use with explosive actuated tools must have a shank diameter of not smaller than 0.145 inch with a shank length of not smaller than 1/2 inch for fastening to steel and not smaller than 1 inch for fastening to concrete.

2.4.1.5 Rivets

Blind rivets must be stainless steel with 1/8 inch nominal diameter shank. Rivets must be threaded stem type if used for other than the fastening of trim. Rivets with hollow stems must have closed ends.

2.4.2 Sealants

Elastomeric type containing no oil or asphalt. Exposed sealant must cure to a rubberlike consistency. Concealed sealant must be the non-hardening type. Seam sealant must be factory-applied, non-skinning, non-drying, and must conform to the roofing manufacturer's recommendations. Silicone-based sealants must not be used in contact with finished metal panels and components unless approved otherwise by the Contracting Officer.

2.4.3 GASKETS AND INSULATING COMPOUNDS

Nonabsorptive and suitable for insulating contact points of incompatible materials. Insulating compounds must be nonrunning after drying.

2.5 Snow Guards

Snow guards shall be the metal bar or pipe type which clamp to the standing seams. Snow guards shall be a manufactured product made from aluminum and/or stainless steel components, finished to match the roof color using the same material and paint type as the panels. Powder coatings, and air-dried paints, pigments or dyes are not acceptable. Snow guards shall be a product from a manufacturer regularly engaged in the production of such products and approved by the SSMR roof manufacturer for use on this project. Method of attachment must be clamping style, utilizing round-point setscrews or other anchorages that do not gall or penetrate any portion of the roof system. Attachment with cup point setscrews is not acceptable. Adhesively attached fixtures and cast or plastic parts are not acceptable.

PART 3 EXECUTION

Do not install building construction materials that show visible evidence of biological growth.

3.1 EXAMINATION

Examine surfaces to receive standing seam metal roofing and flashing. Ensure that surfaces are plumb and true, clean, even, smooth, as dry and free from defects and projections which might affect the installation.

3.2 PROTECTION FROM CONTACT WITH DISSIMILAR MATERIALS

3.2.1 Cementitious Materials

Paint metal surfaces which will be in contact with mortar, concrete, or other masonry materials with one coat of alkali-resistant coating such as heavy-bodied bituminous paint.

3.2.2 Contact with Wood

Where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.3 INSTALLATION

Install in accordance with the approved manufacturer's erection instructions, shop drawings, and diagrams. Panels must be in full and firm contact with attachment clips. Where prefinished panels are cut in the field, or where any of the factory applied coverings or coatings are abraded or damaged in handling or installation, they must, after necessary repairs have been made with material of the same color as the weather coating, be approved before being installed. Seal completely openings through panels. Correct defects or errors in the materials. Replace materials which cannot be corrected in an approved manner with nondefective materials. Provide molded closure strips where indicated and where necessary to provide weathertight construction. Use shims as required to ensure attachment clip line is true. Use a spacing gage at each row of panels to ensure that panel width is not stretched or shortened.

3.3.1 Roof Panels

Apply roofing panels with the standing seams parallel to the slope of the roof. Provide roofing panels in longest practical lengths from ridge to eaves (top to eaves on shed roofs), with no transverse joints except at the junction of ventilators, curbs, skylights, chimneys, and similar openings. Install flashing to assure positive water drainage away from roof penetrations. Locate panel end laps such that fasteners do not engage supports or otherwise restrain the longitudinal thermal movement of panels. Form field-formed seam type system seams in the field with an automatic mechanical seamer approved by the manufacturer. Attach panels to the structure with concealed clips incorporated into panel seams. Clip attachment must allow roof to move independently of the structure, except at fixed points as indicated.

3.3.2 Flashings

Provide flashing, related closures and accessories as indicated and as necessary to provide a weathertight installation. Install flashing to ensure positive water drainage away from roof penetrations. Flash and seal the roof at the ridge, eaves and rakes, and projections through the roof. Place closure strips, flashing, and sealing material in an approved manner that will assure complete weathertightness. Details of installation which are not indicated must be in accordance with the SMACNA 1793, panel manufacturer's approved printed instructions and details, or the approved shop drawings. Allow for expansion and contraction of flashing.

3.3.3 Flashing Fasteners

Fastener spacings must be in accordance with the panel manufacturer's recommendations and as necessary to withstand the design loads indicated. Install fasteners in roof valleys as recommended by the manufacturer of the panels. Install fasteners in straight lines within a tolerance of 1/2 inch in the length of a bay. Drive exposed penetrating type fasteners normal to the surface and to a uniform depth to seat gasketed washers properly and drive so as not to damage factory applied coating. Exercise extreme care in drilling pilot holes for fastenings to keep drills perpendicular and centered. Do not drill through sealant tape. After drilling, remove metal filings and burrs from holes prior to installing fasteners and washers. Torque used in applying fasteners must not exceed that recommended by the manufacturer. Remove panels deformed or otherwise damaged by over-torqued fastenings, and provide new panels.

3.3.4 Rib and Ridge Closure/Closure Strips

Set closure/closure strips in joint sealant material and apply sealant to mating surfaces prior to adding panel.

3.4 PROTECTION OF APPLIED ROOFING

Do not permit storing, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to indicated live load limits of roof construction.

3.5 CLEANING

Clean exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from roofs. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces must be free of dents, creases, waves, scratch marks, solder or weld marks and damage to the finish coating.

3.6 MANUFACTURER'S FIELD INSPECTION

Manufacturer's technical representative must visit the site as necessary during the installation process to assure panels, flashings, and other components are being installed in a satisfactory manner. Manufacturer's technical representative must perform a field inspection during the first 20 squares of roof panel installation and at substantial completion prior to issuance of warranty, as a minimum, and as otherwise requested by the Contracting Officer. Additional inspections must not exceed one for 100 squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors must be performed as requested by the Contracting Officer. Each inspection visit must include a review of the entire installation to date. After each inspection, submit a report, signed by the manufacturer's technical representative, to the Contracting Officer noting the overall quality of work, deficiencies and any other concerns, and recommended corrective actions in detail. Notify Contracting Officer a minimum of 2 working days prior to site visit by manufacturer's technical representative.

3.7 COMPLETED WORK

Completed work must be plumb and true without oil canning, dents, ripples, abrasion, rust, staining, or other damage detrimental to the performance or aesthetics of the completed roof assembly.

-- End of Section --

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SPRAY-APPLIED FIREPROOFING
02/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E119	(2022) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E736	(2000; R 2011) Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC23	(2012; R 2016) Acceptance Criteria for Sprayed Fire-resistant Materials (SFRMs), Intumescent Fire-resistant Coatings and Mastic Fire-resistant Coatings Used to Protect Structural Steel Members

UL SOLUTIONS (UL)

UL 263	(2011; Reprint Aug 2021) UL Standard for Safety Fire Tests of Building Construction and Materials
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Protect all structural steel, undersides of steel floors (if required) and steel roof decks (if required) with spray-applied fireproofing to a fire resistance hour-rating as indicated below, unless otherwise indicated.

1.2.2 Fire Resistance Rating

Fire resistance ratings must be in accordance with the fire rated assemblies listed in UL Fire Resistance. Proposed materials not listed in UL Fire Resistance must have fire resistance ratings at least equal to the UL Fire Resistance ratings as determined by an approved independent testing laboratory, based on tests specified in UL 263 or ASTM E119. Submit reports and test records, attesting that the fireproofing material conforms to the specified requirements. Each test report must conform to the report requirements specified by the test method. For the underside

of the decking use metal lath installed prior to the fireproofing material or Rigid Board Fireproofing Material as outlined in the UL Fire Resistance Directory Volume 1. Apply fireproofing to structural steel members, with the hourly fire resistance rating and in accordance with the UL design or approved equivalent. Use unrestrained fire resistance ratings, unless the architect/engineer has specified that the degree of thermal restraint of the construction meets or exceeds the degree of thermal restraint of the tested assembly. Performance tests must be in accordance with ASTM E119.

1.2.3 Evaluation Reports - ICC-ES Reports

Evaluate materials in accordance with ICC-ES AC23. Include ICC-ES Reports as part of the Submittals below. The reports will identify the product as code compliant and having met the physical performance requirements outlined in paragraphs "Dry Density and Cohesion/Adhesion" through "Air Erosion".

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fireproofing Material; G, DO

SD-06 Test Reports

Fire Resistance Rating; G, DO

Evaluation Reports;

SD-07 Certificates

Installer Qualifications;

Surface Preparation Report; G, RO

Manufacturer's Inspection Report; G, RO

1.4 QUALITY ASSURANCE

1.4.1 Installer Qualifications

Engage an experienced installer that is certified, licensed, or otherwise qualified by the spray-on fireproofing manufacturer as having the necessary experience, staff, and training to install the manufacturer's products in accordance with specified requirements. Submit manufacturer's certification that each listed installer is qualified and trained to install the specified fireproofing. Show evidence that each fireproofing installer has had a minimum of 3 years experience in installing the specified type of fireproofing. Each installer of fireproofing material must be trained, have a minimum of 3 years experience and a minimum of three installations using fireproofing of the type specified. A

manufacturer's willingness to sell its products to the Contractor or installer does not infer qualification of the buyer.

1.4.2 Pre-Installation Meeting

Hold a meeting with the installer, field testing agency, the manufacturer, subcontractors (whose employees come into contact with the fireproofing), and the Contracting Officer prior to the installation of any fireproofing material to review the substrates for acceptability, method of application, applied thickness, patching, repair, inspection and testing procedures. Contractor to review sequencing of intumescent paint application with erection of the precast concrete walls and construction of the cast in place concrete walls so that all surfaces required to be fire rated with intumescent paint will be covered.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver packaged material in the original unopened containers, marked to show the brand name, the manufacturer, and the UL markings. Keep fireproofing material dry until ready to be used, and store off the ground, under cover and away from damp surfaces. Damaged or opened containers will be rejected. Apply material with shelf-life prior to expiration of the paint shelf-life.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Temperature

Maintain substrate and ambient air temperatures above 40 degrees F during application and for 24 hours before and after application. Maintain relative humidity within the limits recommended by the fireproofing manufacturer.

1.6.2 Ventilation

Provide adequate ventilation to properly dry the fireproofing after application. In enclosed areas, provide a minimum of 4 air exchanges per hour by forced air circulation.

PART 2 PRODUCTS

2.1 SPRAY-APPLIED INTUMESCENT EPOXY COATING SYSTEM

Provide a two-component epoxy based intumescent fire protective coating that meets the following requirements.

a. On curing it forms a flexible and tough epoxy barrier which transforms into a ceramic-like, insulating char to provide thermal protection of the substrate in the event of a fire.

b. The coating system includes the manufacturer's required surface preparation, primer, and fire protective layer, and topcoat.

c. The coating system protects the substrate from corrosion and retain its fire protection properties under aggressive chemical environments.

d. Resistant to solvents, acids, alkalis, salts and abrasion while retaining its fire protective properties.

e. Fire-resistance of the system shall be a minimum of two hours. For rooms enclosed by 3-hour rated walls, the fireproofing shall be 3-hour rated.

2.1.1 Percent Solids by Weight

100 percent

2.1.2 Volatile Organic Compound (VOC)

Paint shall be low VOC.

2.1.3 Color

Color shall be white or off-white.

2.1.4 In Service Temperature Restrictions

Up to 150 degrees F

2.1.5 Application Method

Air spray or specialized plural component airless equipment approved by the manufacturer. Troweling can be used for small areas or touch-up work.

2.1.6 Drying Time

Approximately 24 hours to achieve a Shore D hardness of 25.

2.1.7 Shelf Life

Minimum shelf life under proper storage condition is 1 Year from date of manufacture.

2.1.8 Pot Life

Approximately 40 minutes at 77 degrees F and 50 percent relative humidity. Pot life is not a factor when using specialized plural component airless spray equipment.

2.1.9 Flash Point

Greater than 212 degrees F Pensky-Martens for each component.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Thoroughly clean surfaces to be fireproofed of dirt, grease, oil, paint, primers, loose rust, rolling lubricant, mill scale or other contaminants that will interfere with the proper bonding of the sprayed fireproofing to the substrate. Test painted/primed steel substrates in accordance with ASTM E736, with specified sprayed fireproofing material, to provide the required fire-resistance rating; painted or primed steel surfaces may require a fireproofing bond test to determine if the paint formulation will impair proper adhesion. Certify the acceptability of surfaces to receive sprayed-applied fireproofing by inspection and submit a Surface Preparation Report accordingly. List the structural members and the areas that have been inspected and certified. Clear overhead areas to be

fireproofed of all obstructions interfering with the uniform application of the spray-applied fireproofing. Install hardware such as support sleeves, inserts, clips, hanger attachment devices and the like prior to the application of the fireproofing. Condition of the surfaces must be acceptable to the manufacturer prior to application of spray-applied fireproofing. Applications listed for use on primed surfaces must be in accordance with the manufacturer's recommendations and standards, and detailed in submittal item SD-03 Product Data.

3.2 PROTECTION

Cover surfaces not to receive spray-applied fireproofing to prevent contamination by splatter, rebound and overspray. Cover exterior openings in areas to receive spray-applied fireproofing prior to and during application of fireproofing with tarpaulins or other approved material. Clean surfaces not to receive fireproofing of fireproofing and sealer.

3.3 FIREPROOFING MATERIAL

Mix fireproofing material in accordance with the manufacturer's recommendations. Submit data identifying performance characteristics of fireproofing material. Data includes recommended application requirements and indicate thickness of fireproofing to be applied to achieve each required fire rating.

3.4 APPLICATION

3.4.1 Sequence

Prior to application of fireproofing, inspect and approve application equipment, water supply and pressure, and the application procedures. If fireproofing is required to be applied to underside of steel roof deck and steel floor assemblies, apply it only after respective roof or floor construction is complete. Do not allow roof or floor traffic during application. Apply fireproofing material prior to the installation of ductwork, piping and conduits, and consider sequencing of cast-in-place walls which would interfere with uniform application of the fireproofing.

3.4.2 Application of Spray-Applied Intumescent Epoxy Coating System

Prepare surfaces and apply the spray-applied Intumescent epoxy coating system in accordance with the manufacturer's written recommendations.

3.5 MANUFACTURER'S SERVICES

3.5.1 General

The manufacturer, or its representative, must be onsite prior to, periodically during, and at completion of the application, to provide the specified inspections and certifications; and to ensure that preparations are adequate and that the material is applied according to manufacturer's recommendations and the contract requirements.

3.5.2 Manufacturer's Inspection

Inspect the fireproofing work after the work is completed on each floor or area, including testing, repair and clean-up, and certify that the work complies with the manufacturer's criteria and recommendations. Before the sprayed material is covered, and after all of the fireproofing work is

completed, including repair, testing, and clean-up; and after mechanical, electrical and other work in contact with fireproofing material has been completed, re-inspect the work and certify that the entire project complies with the manufacturer's criteria and recommendations. Obtain and submit the Manufacturer's Inspection Report and certifications of approval stating that the spray-applied fireproofing in the entire project complies with the manufacturer's criteria and recommendations.

3.6 CLEANUP

Thoroughly clean surfaces not indicated to receive fireproofing of sprayed material within a 24 hour period after application.

-- End of Section --

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SECTION 07 84 00

FIRESTOPPING
05/10, CHG 1: 08/13

PART 1 GENERAL

1.1 SUMMARY

Furnish and install tested and listed firestopping systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps.

a. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents.

b. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; do not allow firestopping material to interfere with the required movement of the joint.

Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof or floor deck above and at the intersection of shaft assemblies and adjoining fire resistance rated assemblies.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E119	(2022) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E699	(2009) Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components
ASTM E814	(2013a; R 2017) Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM E1399/E1399M	(1997; R 2022) Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
ASTM E1966	(2015; R 2019) Standard Test Method for

	Fire-Resistive Joint Systems
ASTM E2174	(2020a) Standard Practice for On-Site Inspection of Installed Firestop Systems
ASTM E2307	(2020) Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus
ASTM E2393	(2020a) Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers

FM GLOBAL (FM)

FM 4991	(2013) Approval of Firestop Contractors
FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalg

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

UL SOLUTIONS (UL)

UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 1479	(2015; Reprint May 2021) Fire Tests of Through-Penetration Firestops
UL 2079	(2015; Reprint Jul 2020) Tests for Fire Resistance of Building Joint Systems
UL Fire Resistance	(2014) Fire Resistance Directory

1.3 SEQUENCING

Coordinate the specified work with other trades. Apply firestopping materials, at penetrations of pipes and ducts, prior to insulating, unless insulation meets requirements specified for firestopping. Apply firestopping materials. at building joints and construction gaps, prior to completion of enclosing walls or assemblies. Locate cast-in-place firestop devices and install in place before concrete placement. Install pipe, conduit or cable bundles through cast-in-place device after concrete placement but before area is concealed or made inaccessible. Firestop material must be inspected and approved prior to final completion and enclosing of any assemblies that may conceal installed firestop.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL

PROCEDURES:

SD-02 Shop Drawings

Firestopping System; G, DO

SD-03 Product Data

Firestopping Materials; G, DO

SD-06 Test Reports

Inspection; G, RO

SD-07 Certificates

Inspector Qualifications

Firestopping Materials

Installer Qualifications; G, RO

1.5 QUALITY ASSURANCE

1.5.1 Installer

Engage an experienced Installer who is:

a. FM Research approved in accordance with FM 4991, operating as a UL Certified Firestop Contractor, or

b. Certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products in accordance with specified requirements. Submit documentation of this experience. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer installer qualifications on the buyer. The Installer must be a trained representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures. Obtain and submit installer's written certification of training, and retain proof of certification for duration of firestop installation.

1.5.2 Inspector Qualifications

The inspector must meet the criteria contained in ASTM E699 for agencies involved in quality assurance and must have a minimum of two years experience in construction field inspections of firestopping systems, products, and assemblies. The inspector must be completely independent of, and divested from, the installer, the manufacturer, and the supplier of any material or item being inspected. The inspector must not be a competitor of the installer, the contractor, the manufacturer, or supplier of any material or item being inspected. Include in the qualifications submittal a notarized statement assuring compliance with the requirements stated herein.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the original unopened packages or containers showing name of the manufacturer and the brand name. Store materials off the ground, protected from damage and exposure to elements and temperatures in accordance with manufacturer requirements. Remove damaged or deteriorated materials from the site. Use materials within their indicated shelf life.

PART 2 PRODUCTS

2.1 FIRESTOPPING SYSTEM

Submit detail drawings including manufacturer's descriptive data, typical details conforming to UL Fire Resistance or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, submit a manufacturer's engineering judgment, derived from similar UL system designs or other tests for review and approval prior to installation. Submittal must indicate the firestopping material to be provided for each type of application. When more than a total of 5 penetrations and/or construction joints are to receive firestopping, provide drawings that indicate location, "F" "T" and "L" ratings, and type of application.

Also, submit a written report indicating locations of and types of penetrations and types of firestopping used at each location; record type by UL list printed numbers.

2.2 FIRESTOPPING MATERIALS

Provide firestopping materials, supplied from a single domestic manufacturer, consisting of commercially manufactured, asbestos-free, nontoxic products FM APP GUIDE approved, or UL listed, for use with applicable construction and penetrating items, complying with the following minimum requirements:

2.2.1 Fire Hazard Classification

Provide material that has a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E84 or UL 723. Provide an approved firestopping material as listed in UL Fire Resistance or by a nationally recognized testing laboratory.

2.2.2 Toxicity

Provide material that is nontoxic and carcinogen free to humans at all stages of application or during fire conditions and does not contain hazardous chemicals or require harmful chemicals to clean material or equipment.

2.2.3 Fire Resistance Rating

Firestop systems must be UL Fire Resistance listed or FM APP GUIDE approved with "F" rating at least equal to fire-rating of fire wall or floor in which penetrated openings are to be protected. Where required, firestop systems must also have "T" rating at least equal to the fire-rated floor in which the openings are to be protected.

2.2.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph SUMMARY, must provide "F", "T" and "L" fire resistance ratings in accordance with ASTM E814 or UL 1479. Provide fire resistance ratings as follows:

2.2.3.1.1 Penetrations of Fire Resistance Rated Walls and Partitions

F Rating = Rating of wall or partition being penetrated.

2.2.3.1.2 Penetrations of Fire Resistance Rated Floors, Floor-Ceiling Assemblies and the Ceiling Membrane of Roof-Ceiling Assemblies

F Rating = 1 hour, T Rating = 1 hour. Where the penetrating item is outside of a wall cavity the F rating must be equal to the fire resistance rating of the floor penetrated, and the T rating must be in accordance with the requirements of ICC IBC.

2.2.3.1.3 Penetrations of Fire and Smoke Resistance Rated Walls, Floors, Floor-Ceiling Assemblies, and the ceiling membrane of Roof-Ceiling Assemblies

F Rating = 1 hour, T Rating = 1 hour and L Rating = Where L rating is required.

2.2.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph SUMMARY, and gaps such as those between floor slabs and curtain walls must be the same as the construction in which they occur. Provide construction joints and gaps with firestopping materials and systems that have been tested in accordance with ASTM E119, ASTM E1966 or UL 2079 to meet the required fire resistance rating. Provide curtain wall joints with firestopping materials and systems that have been tested in accordance with ASTM E2307 to meet the required fire resistance rating. Systems installed at construction joints must meet the cycling requirements of ASTM E1399/E1399M or UL 2079. Provide a minimum class II movement capability for all joints at the intersection of the top of a fire resistance rated wall and the underside of a fire-rated floor, floor ceiling, or roof ceiling assembly.

2.2.4 Material Certification

Submit certificates attesting that firestopping material complies with the specified requirements. Provide certification of compliance with UL 1479 for all intumescent firestop materials used in through penetration systems.

PART 3 EXECUTION

3.1 PREPARATION

Areas to receive firestopping must be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement must be sound and capable of supporting device. Prepare surfaces as recommended by the manufacturer.

3.2 INSTALLATION

Completely fill void spaces with firestopping material regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 4 inches or more in any direction must be capable of supporting the same load as the floor is designed to support or be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Install firestopping in accordance with manufacturer's written instructions. Provide tested and listed firestop systems in the following locations, except in floor slabs on grade:

a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.

b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.

c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.

d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.

e. Construction joints in floors and fire rated walls and partitions.

f. Other locations where required to maintain fire resistance rating of the construction.

3.2.1 Insulated Pipes and Ducts

Cut and remove thermal insulation where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Replace thermal insulation with a material having equal thermal insulating and firestopping characteristics.

3.2.2 Fire Dampers

Install and firestop fire dampers in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION. Firestop installed with fire damper must be tested and approved for use in fire damper system. Firestop installed with fire damper must be tested and approved for use in fire damper system.

3.2.3 Data and Communication Cabling

Seal cabling for data and communication applications with re-enterable firestopping products and/or devices .

3.2.3.1 Re-Enterable Devices

Provide firestopping devices that are pre-manufactured modular devices, containing built-in self-sealing intumescent inserts. Allow for cable moves, additions or changes without the need to remove or replace any firestop materials. Devices must be capable of maintaining the fire resistance rating of the penetrated membrane at 0 percent to 100 percent visual fill of penetrants; while maintaining "L" rating of <10 cfm/sf measured at ambient temperature and 400 degrees F at 0 percent to 100 percent visual fill.

3.2.3.2 Re-Sealable Products

Provide firestopping pre-manufactured modular products, containing self-sealing intumescent inserts. Allow for cable moves, additions or changes. Provide devices capable of maintaining the fire resistance rating of the penetrated membrane at 0 percent to 100 percent visual fill of penetrants.

3.3 INSPECTION

For all projects, do not cover or enclose the firestopped areas until inspection is complete and approved by the Contracting Officer. The inspector must inspect the applications initially to ensure adequate preparations (clean surfaces suitable for application, etc.) and periodically during the work to assure that the completed work has been accomplished according to the manufacturer's written instructions and the specified requirements. Submit written reports indicating locations of and types of penetrations and types of firestopping used at each location; record type by UL listed printed numbers.

3.3.1 Inspection Standards

Inspect all firestopping in accordance with ASTM E2393 and ASTM E2174 for firestop inspection, and document inspection results to be submitted.

3.3.2 Inspection Reports

Submit inspection report stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

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SECTION 07 92 00

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08/23

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SECTION 07 92 00

JOINT SEALANTS
08/23

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C509	(2006; R 2021) Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C734	(2015; R 2019) Standard Test Method for Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
ASTM C919	(2022) Standard Practice for Use of Sealants in Acoustical Applications
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C1193	(2016) Standard Guide for Use of Joint Sealants
ASTM C1311	(2022) Standard Specification for Solvent Release Sealants
ASTM C1521	(2019; R 2020) Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
ASTM D217	(2021a) Standard Test Methods for Cone Penetration of Lubricating Grease
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1667	(2022) Standard Specification for Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2452	(2015; R 2019) Standard Test Method for Extrudability of Oil- and Resin-Base Caulking Compounds
ASTM D2453	(2015; R 2020; E 2020) Standard Test Method for Shrinkage and Tenacity of Oil- and Resin-Base Caulking Compounds

ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants;

Primers;

Bond Breakers;

Backstops;

Caulking;

Cleaning Solvents;

SD-06 Test Reports

Field Adhesion; G, RO

SD-07 Certificates

Indoor Air Quality For Interior Sealants;

Indoor Air Quality For Interior Floor Joint Sealants;

Indoor Air Quality For Interior Acoustical Sealants;

Indoor Air Quality For Interior Caulking;

1.3 PRODUCT DATA

Include storage requirements, shelf life, curing time, instructions for mixing and application, and accessories. Provide manufacturer's Safety Data Sheets (SDS) for each solvent, primer and sealant material proposed.

1.4 CERTIFICATIONS

1.4.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

1.4.1.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.5 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 40 and 90 degrees F.

1.6 DELIVERY AND STORAGE

Deliver materials to the jobsite in unopened manufacturers' sealed shipping containers, with brand name, date of manufacture, color, and material designation clearly marked thereon. Label elastomeric sealant containers to identify type, class, grade, and use. Handle and store materials in accordance with manufacturer's printed instructions. Prevent exposure to foreign materials or subjection to sustained temperatures exceeding 90 degrees F or lower than 0 degrees F. Keep materials and containers closed and separated from absorptive materials such as wood and insulation.

1.7 QUALITY ASSURANCE

1.7.1 Compatibility with Substrate

Verify that each sealant is compatible for use with each joint substrate in accordance with sealant manufacturer's printed recommendations for each application.

1.7.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

1.7.3 Adhesion

Provide in accordance with ASTM C1193 or ASTM C1521.

PART 2 PRODUCTS

2.1 SEALANTS

Provide sealant products that have been tested, found suitable, and documented as such by the manufacturer for the particular substrates to which they will be applied. For fire rated sealants submit with 07 84 00 FIRESTOPPING.

In areas with ambient temperatures that exceed 110 degrees F, do not use polybutene, bituminous, acrylic-latex, polyvinyl acetate latex sealants, polychloroprene (neoprene), polyvinyl chloride (PVC), and polyurethane foams, and neoprene, PVC, and styrene butadiene rubber extruded seals and closure strips due to these materials having maximum recommended surface temperature ranges from 130 to 180 degrees F.

2.1.1 Interior Sealants

Provide ASTM C920, Type S or M, Grade NS, Class 12.5, Use NT. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior sealants. Location(s) and color(s) of sealant for the following (Note, color "as selected" refers to manufacturer's full range of color options):

LOCATION	COLOR
a. Small voids between walls or partitions and adjacent lockers, casework, shelving, door frames, built-in or surface mounted equipment and fixtures, and similar items.	As selected
b. Perimeter of frames at doors, windows, and access panels which adjoin exposed interior concrete and masonry surfaces.	As selected
c. Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed.	As selected
d. Joints between edge members for acoustical tile and adjoining vertical surfaces.	As selected
e. Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted.	As selected
f. Joints between bathtubs and ceramic tile; joints between shower receptors and ceramic tile; joints formed where non-planar tile surfaces meet.	As selected
g. Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change.	As selected

LOCATION	COLOR
h. Behind escutcheon plates at valve pipe penetrations and showerheads in showers.	As selected
i.	

2.1.2 Exterior Sealants

For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T. Hybrid sealant meeting ASTM C920, Type S, Grade NS, Class 50, use NT, M, A, G, or O. Provide location(s) and color(s) of sealant as follows (Note, color "as selected" refers to manufacturer's full range of color options):

LOCATION	COLOR
a. Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations.	Match adjacent surface color
b. Joints between new and existing exterior masonry walls.	Match adjacent surface color
c. Masonry joints where shelf angles occur.	Match adjacent surface color
d. Joints in wash surfaces of stonework.	Match adjacent surface color
e. Expansion and control joints.	Match adjacent surface color
f. Interior face of expansion joints in exterior concrete or masonry walls where metal expansion joint covers are not required.	Match adjacent surface color
g. Voids where items pass through exterior walls.	Match adjacent surface color
h. Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels.	Match adjacent surface color
i. Metal-to-metal joints where sealant is indicated or specified.	Match adjacent surface color

LOCATION	COLOR
j. Joints between ends of gravel stops, fascia, copings, and adjacent walls.	Match adjacent surface color
k.	

2.1.3 Floor Joint Sealants

ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior floor joint sealants. Provide location(s) and color(s) of sealant as follows (Note, color "as selected" refers to manufacturer's full range of color options):

LOCATION	COLOR
a. Seats of metal thresholds for exterior doors.	As selected
b. Control and expansion joints in floors, slabs, ceramic tile, and walkways.	As selected

2.1.4 Acoustical Sealants

Rubber or polymer based acoustical sealant in accordance with ASTM C919 to have a flame spread of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84. Provide non-staining acoustical sealant with a consistency of 250 to 310 when tested in accordance with ASTM D217. Acoustical sealant must remain flexible and adhesive after 500 hours of accelerated weathering as specified in ASTM C734. Provide sealant products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior acoustical sealants.

2.1.5 Preformed Sealants

Provide preformed sealants of polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealants capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 30 to plus 160 degrees F, sealants must be non-bleeding and have no loss of adhesion.

2.1.5.1 Foam Strip

Provide foam strip of polyurethane . Provide foam strip capable of sealing out moisture, air, and dust when installed and compressed in

accordance with manufacturer's printed instructions. Service temperature must be minus 40 to plus 275 degrees F. Install untreated strips with adhesive to hold them in place. Do not allow adhesive to stain or bleed onto adjacent finishes. Saturate treated strips with butylene waterproofing or impregnate with asphalt.

2.2 PRIMERS

Non-staining, quick drying type and consistency as recommended by the sealant manufacturer for the particular application. Provide primers for interior applications that meet the indoor air quality requirements of the paragraph INTERIOR SEALANTS above.

2.3 BOND BREAKERS

Type and consistency as recommended by the sealant manufacturer to prevent adhesion of the sealant to the backing or to the bottom of the joint. Provide bond breakers for interior applications that meet the indoor air quality requirements of the paragraph INTERIOR SEALANTS above.

2.4 BACKSTOPS

Provide glass fiber roving, neoprene, butyl, polyurethane, or polyethylene foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 to 33 percent oversized backing for closed cell and 40 to 50 percent oversized backing for open cell material, unless otherwise indicated. Provide backstop material that is compatible with sealant. Do not use oakum or other types of absorptive materials as backstops.

2.4.1 Rubber

Provide in accordance with ASTM D1056, Type 2, closed cell, Class A cellular rubber sponge backing.

2.4.2 PVC

Provide in accordance with ASTM D1667, Grade VO 12, open-cell foam, for polyvinyl chloride (PVC) backing.

2.4.3 Synthetic Rubber

Provide in accordance with ASTM C509, Option I, Type I preformed rods or tubes for synthetic rubber backing.

2.4.4 Neoprene

Provide in accordance with ASTM D1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2 for neoprene backing.

2.4.5 Butyl Rubber Based

Provide in accordance with ASTM C1311, from a single component, with solvent release. color as selected from manufacturer's full range of color choices .

2.4.6 Silicone Rubber Base

Provide in accordance with ASTM C920, from a single component, with

solvent release, Non-sag. Color as selected from manufacturer's full range of color choices .

2.5 CAULKING

For interior use and only where there is little or no anticipated joint movement. Provide in accordance with ASTM D2452 and ASTM D2453, for oil and resin-based caulking. Provide products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide certification or validation of indoor air quality for interior caulking.

2.6 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer and in accordance with environmental requirements herein. Protect adjacent aluminum and bronze surfaces from solvents. Provide solvents for interior applications that meet the indoor air quality requirements of the paragraph INTERIOR SEALANTS above.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

Perform a field adhesion test in accordance with manufacturer's instructions and ASTM C1193, Method A or ASTM C1521, Method A, Tail Procedure. Remove sealants that fail adhesion testing; clean substrates, reapply sealants, and re-test. Test sealants adjacent to failed sealants. Submit field adhesion test report indicating tests, locations, dates, results, and remedial actions taken.

3.2 SURFACE PREPARATION

Prepare surfaces according to manufacturer's printed installation instructions. Clean surfaces from dirt, frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would destroy or impair adhesion. Remove oil and grease with solvent; thoroughly remove solvents prior to sealant installation. Wipe surfaces dry with clean cloths. When resealing an existing joint, remove existing caulk or sealant prior to applying new sealant. For surface types not listed below, provide in accordance with sealant manufacturer's printed instructions for each specific surface.

3.2.1 Steel Surfaces

Remove loose mill scale by sandblasting or, if sandblasting is impractical or would damage finished work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue free solvent. Remove resulting debris and solvent residue prior to sealant installation.

3.2.2 Aluminum or Bronze Surfaces

Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and residual adhesive prior to sealant application. For removing protective coatings and final cleaning, use non-staining solvents recommended by the manufacturer of the item(s) containing aluminum or

bronze surfaces.

3.2.3 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Remove laitance, efflorescence and loose mortar from the joint cavity. Remove resulting debris prior to sealant installation.

3.2.4 Wood Surfaces

Ensure wood surfaces that will be in contact with sealants are free of splinters, sawdust and other loose particles.

3.3 SEALANT PREPARATION

Do not add liquids, solvents, or powders to sealants. Mix multicomponent elastomeric sealants in accordance with manufacturer's printed instructions.

3.4 APPLICATION

3.4.1 Joint Width-To-Depth Ratios

Acceptable Ratios:

JOINT WIDTH	JOINT DEPTH	
	Minimum	Maximum
For metal, glass, or other nonporous surfaces:		
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch	1/2 of width	Equal to width
For wood, concrete, masonry, stone:		
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
over 1/2 inch to 1 inch	1/2 inch	5/8 inch
Over 1 inch	prohibited	

Unacceptable Ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining work. Grinding is prohibited at metal surfaces.

3.4.2 Unacceptable Sealant Use

Do not install sealants in lieu of other required building enclosure weatherproofing components such as flashing, drainage components, and joint closure accessories, or to close gaps between walls, floors, roofs, windows, and doors, that exceed acceptable installation tolerances.

Remove sealants that have been used in an unacceptable manner and correct building enclosure deficiencies to comply with contract documents requirements.

3.4.3 Masking Tape

Place masking tape on the finished surface on one or both sides of joint cavities to protect adjacent finished surfaces from primer or sealant smears. Remove masking tape within 10 minutes of joint filling and tooling.

3.4.4 Backstops

Provide backstops dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide joints in specified depths. Provide backstops where indicated and where backstops are not indicated but joint cavities exceed the acceptable maximum depths specified in JOINT WIDTH-TO-DEPTH RATIOS Table.

3.4.5 Primer

Clean out loose particles from joints immediately prior to application of. Apply primer to joints in concrete masonry units, wood, and other porous surfaces in accordance with sealant manufacturer's printed instructions. Do not apply primer to exposed finished surfaces.

3.4.6 Bond Breaker

Provide bond breakers to surfaces not intended to bond in accordance with, sealant manufacturer's printed instructions for each type of surface and sealant combination specified.

3.4.7 Sealants

Provide sealants compatible with the material(s) to which they are applied. Do not use a sealant that has exceeded its shelf life or has jelled and cannot be discharged in a continuous flow from the sealant gun. Apply sealants in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Work sealant into joints so as to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion. Apply sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled or unfilled joints, apply additional sealant, and tool smooth as specified. Apply sealer over sealants in accordance with the sealant manufacturer's printed instructions.

3.5 PROTECTION AND CLEANING

3.5.1 Protection

Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled and no residual tape marks remain.

3.5.2 Final Cleaning

Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean and neat condition.

a. Masonry and Other Porous Surfaces: Immediately remove fresh sealant that has been smeared on adjacent masonry, rub clean with a solvent, and remove solvent residue, in accordance with sealant manufacturer's printed instructions. Allow excess sealant to cure for 24 hours then remove by wire brushing or sanding. Remove resulting debris.

b. Metal and Other Non-Porous Surfaces: Remove excess sealant with a solvent moistened cloth. Remove solvent residue in accordance with solvent manufacturer's printed instructions.

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SECTION 08 11 13

STEEL DOORS AND FRAMES
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A879/A879M	(2012; R 2017) Standard Specification for Steel Sheet, zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM C578	(2023) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C591	(2022) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM D2863	(2019) Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.115	(2016) Hardware Preparation in Steel Doors and Steel Frames

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2022) Standard for Fire Doors and Other Opening Protectives
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR 111	(2009) Recommended Details for Standard Steel Doors, Frames, and Accessories and Related Components
SDI/DOOR 113	(2023) Standard Practice for Determining the Steady-State Thermal Transmittance of Steel Door and Frame Assemblies
SDI/DOOR A250.4	(2022) Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors
SDI/DOOR A250.6	(2020) Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
SDI/DOOR A250.8	(2023) Specifications for Standard Steel Doors and Frames
SDI/DOOR A250.11	(2022) Recommended Erection Instructions for Steel Frames

UL SOLUTIONS (UL)

UL 10C	(2016; Reprint May 2021) UL Standard for Safety Positive Pressure Fire Tests of Door Assemblies

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G, DO

Frames; G, DO

Accessories

Schedule of Doors; G, DO

Schedule of Frames; G, DO

SD-03 Product Data

Doors; G, DO

Frames; G, DO

Accessories

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 1/4 inch airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.

PART 2 PRODUCTS

2.1 STANDARD STEEL DOORS

SDI/DOOR A250.8, except as specified otherwise. Prepare doors to receive door hardware as specified in Section 08 71 00 DOOR HARDWARE. Undercut where indicated. Provide exterior doors with top edge closed flush and sealed to prevent water intrusion. Provide doors at 1-3/4 inch thick, unless otherwise indicated. Provide door material that uses a minimum of 25 percent recycled content. Provide data indicating percentage of recycled content for steel door product.

2.1.1 Classification - Level, Performance, Model

2.1.1.1 Heavy Duty Doors

SDI/DOOR A250.8, Level 2, physical performance Level B, with core construction as required by the manufacturer for interior doors.

2.1.1.2 Maximum Duty Doors

SDI/DOOR A250.8, Level 4, physical performance Level A, with core construction as required by the manufacturer for exterior doors, of size(s) and design(s) indicated.

2.2 INSULATED STEEL DOOR SYSTEMS

Provide insulated steel doors and frames in accordance with SDI/DOOR 113 for all exterior doors. Meet energy requirements including Solar Heat Gain Coefficient (SHGC) and U-factor. Provide insulated steel doors with a core of polyurethane foam; face sheets, edges, and frames of galvanized steel not lighter than 23 gage, 16 gage, and 16 gage respectively; magnetic weatherstripping; nonremovable-pin hinges; thermal-break aluminum threshold; and vinyl door bottom. Provide to doors and frames a phosphate treatment, rust-inhibitive primer, and baked acrylic enamel finish. Test doors in accordance with SDI/DOOR A250.4 and meet the requirements for Level C. Prepare doors to receive specified hardware. Provide doors 1-3/4 inch thick.

2.3 ACCESSORIES

2.3.1 Astragals

For pairs of exterior steel doors which will not have aluminum astragals or removable mullions, as specified in Section 08 71 00 DOOR HARDWARE

provide overlapping steel astragals with the doors.

2.3.2 Moldings

Provide moldings around glass of interior and exterior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings.

2.4 INSULATION CORES

Provide insulating cores at all exterior doors and other specific doors noted in the door schedule, and provide an apparent U-factor of .48 in accordance with SDI/DOOR 113 and conforming to:

a. Rigid Cellular Polyisocyanurate Foam: ASTM C591, Type I or II, foamed-in-place or in board form, with oxygen index of not less than 22 percent when tested in accordance with ASTM D2863; or

b. Rigid Polystyrene Foam Board: ASTM C578, Type I or II; or

c. Mineral board: ASTM C612, Type I.

2.5 STANDARD STEEL FRAMES

SDI/DOOR A250.8, Level 4, except as otherwise specified. Form frames to sizes and shapes indicated, with welded corners. Provide steel frames for doors, unless otherwise indicated. Provide frame product that uses a minimum of 25 percent recycled content. Provide data indicating percentage of recycled content for steel frame product.

2.5.1 Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

Weld frames in accordance with the recommended practice of the Structural Welding Code Sections 1 through 6, AWS D1.1/D1.1M and in accordance with the practice specified by the producer of the metal being welded.

2.5.2 Stops and Beads

Provide form and loose stops and beads from 20 gage steel. Provide for glazed and other openings in standard steel frames. Secure beads to frames with oval-head, countersunk Phillips self-tapping sheet metal screws or concealed clips and fasteners. Space fasteners approximately 12 to 16 inch on center. Miter molded shapes at corners. Butt or miter square or rectangular beads at corners.

2.5.3 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated not lighter than 18 gage.

2.5.3.1 Wall Anchors

Provide at least three anchors for each jamb. For frames which are more than 7.5 feet in height, provide one additional anchor for each jamb for each additional 2.5 feet or fraction thereof.

Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding;

b. Completed openings: Secure frames to previously placed concrete with expansion bolts in accordance with SDI/DOOR 111.

2.5.3.2 Floor Anchors

Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member.

2.6 FIRE DOORS AND FRAMES

Provide fire doors and frames in accordance with NFPA 80 and this specification. Include insulated core materials in fire doors where indicated in the door schedule.

2.6.1 Labels

Provide fire doors and frames bearing the label of Underwriters Laboratories (UL), Factory Mutual Engineering and Research (FM), or Warnock Hersey International (WHI) attesting to the rating required. Testing must be in accordance with NFPA 252 or UL 10C. Provide labels that are metal with raised letters, bearing the name or file number of the door and frame manufacturer. Labels must be permanently affixed at the factory to frames and to the hinge edge of the door. Do not paint door and labels.

2.6.2 Astragal on Fire Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements.

2.7 EXTERIOR FRAMES

Provide thermal insulation in all exterior frames. Provide frames of a minimum Level 4, with frames of a minimum thickness of 0.067 inch, 14 gage.

2.8 HARDWARE PREPARATION

Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI/DOOR A250.8 and SDI/DOOR A250.6. For additional requirements refer to ANSI/BHMA A156.115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Punch door frames, with the exception of frames that will have weatherstripping to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.9 FINISHES

2.9.1 Factory-Primed Finish

Thoroughly clean all surfaces of doors and frames then chemically treat and factory prime with a rust inhibiting coating as specified in

SDI/DOOR A250.8 or paintable A25 galvannealed steel without primer. Where coating is removed by welding, apply touchup of factory primer.

2.9.2 Hot-Dip Zinc-Coated and Factory-Primed Finish

Fabricate doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A924/A924M and ASTM A653/A653M. The coating weight must meet or exceed the minimum requirements for coatings having 0.4 ounces per square foot, total both sides, i.e., A40. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in SDI/DOOR A250.8.

2.9.3 Electrolytic Zinc-Coated Anchors and Accessories

Provide electrolytically deposited zinc-coated steel in accordance with ASTM A879/A879M, Commercial Quality, Coating Class A. Phosphate treat and factory prime zinc-coated surfaces as specified in SDI/DOOR A250.8.

2.10 FABRICATION AND WORKMANSHIP

Provide finished doors and frames that are strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Provide molded members that are clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints must be well formed and in true alignment. Conceal fastenings where practicable.

2.11 PROVISIONS FOR GLAZING

Materials are specified in Section 08 81 00, GLAZING.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Frames

Set frames in accordance with SDI/DOOR A250.11. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction.

3.1.2 Doors

Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.

3.1.3 Fire Doors and Frames

Install fire doors and frames, including hardware, in accordance with NFPA 80.

3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as

directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same type used for shop coat.

3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

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SECTION 08 33 23

OVERHEAD COILING DOORS
08/20, CHG 1: 02/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B29.400	(2001; (R 2008) (R 2013) (R 2018) (R 2023)) Combination, "H" Type Mill Chains, and Sprockets

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or

	Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A666	(2023) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E330/E330M	(2014; R 2021) Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM F568M	(2007) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

DOOR AND ACCESS SYSTEM MANUFACTURERS ASSOCIATION (DASMA)

ANSI/DASMA 108	(2017) Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA ST 1	(1988; R 1994; R 1997) Specialty

Transformers (Except General Purpose Type)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 80	(2022) Standard for Fire Doors and Other Opening Protectives

UL SOLUTIONS (UL)

UL 325	(2017; Reprint Feb 2020) UL Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems

1.2 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings

SD-03 Product Data

Overhead Coiling Doors; G, DO

Counterbalancing Mechanism; G, DO

Electric Door Operators; G, DO

Fire-Rated Door Assembly; G, DO

Recycled content for steel curtain slats

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals, Data Package 2; G, RO

SD-11 Closeout Submittals

Warranty; G, RO

1.3 QUALITY CONTROL

Provide fire-rated door assembly bearing the Underwriters Laboratories, Warnock Hersey, Factory Mutual or other nationally recognized testing laboratory label for the rating listed on the drawings. Provide a permanent label for each door showing the manufacturer's name and address, and the model/serial number of the door.

Provide oversized fire-rated door assemblies with a listing agency oversize label, or a certificate signed by an official of the manufacturing company certifying that the door and operator are designed to meet the specified requirements.

1.3.1 Warranty

Furnish a written guarantee that the helical spring and counterbalance mechanism are free from defects in material and workmanship for not less than two years after completion and acceptance of the project.

Warrant that upon notification by the Government, any defects in material, workmanship, and door operation are immediately correct within the same time period covered by the guarantee, at no cost to the Government.

1.3.2 Operation And Maintenance Submittals

Submit two copies of the operation and maintenance manuals 30 calendar days prior to testing the Overhead Coiling Door Assemblies. Update and resubmit data for final approval no later than 30 calendar days prior to cContract completion.

Submit Operation and Maintenance Manuals for Overhead Coiling Door Assemblies, including the following items:

Electric Door Operators
Hood
Counterbalancing Mechanism
Painting

Provide operation and maintenance manuals which are consistent with manufacturer's standard brochures, schematics, printed instructions, operating procedures, and safety precautions.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Store doors in an adequately ventilated dry location that is free from dirt and dust, water, or other contaminants. Store in a manner that permits easy access for inspection and handling. Handle doors carefully to prevent damage. Remove damaged items that cannot be restored to like-new condition and provide new items.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide overhead coiling doors with interlocking slats, complete with anchoring and door hardware, guides, hood, and operating mechanisms, and designed for use on openings as indicated. Doors must be spring counterbalanced, rolling type, and designed for use on exterior or interior openings, as indicated. Doors must be operated by electric-power with auxiliary hand chain operation. Doors to be surface-mounted type with guides at jambs set back a sufficient distance to provide a clear opening when door is in open position. Mount exterior doors on interior face of walls.

2.1.1 Design Requirements

2.1.1.1 Door Detail Shop Drawings

Provide installation drawings for door assemblies which show: elevations of each door type, shape and thickness of materials, finishes, details of joints and connections, details of guides and fittings, rough opening dimensions, location and description of hardware, anchorage locations, and counterbalancing mechanism and door operator details. Show locations of replaceable fusible links on wiring diagrams for power, signal and controls. For motor-operated doors include supporting brackets for motors, location, type, and ratings of motors, and safety devices. Include a schedule showing the location of each door with the drawings.

2.1.2 Performance Requirements

2.1.2.1 Wind Loading

Design and fabricate door assembly to withstand the wind loading pressure of at least 88 pounds per square foot for exterior doors and at least 16 pounds per square foot for interior doors in accordace with ANSI/DASMA 108. Provide test data showing compliance with ASTM E330/E330M. Sound engineering principles may be used to interpolate or extrapolate test results to door sizes not specifically tested. Ensure that the complete assembly meets or exceeds the requirements of ASCE 7-16.

2.1.2.2 Fire-Rated Doors, Frames, and Hardware

Provide fire-rated doors, frames, and hardware that are tested, rated, and labeled in accordance with Underwriters Laboratories, Factory Mutual or Warnock Hersey. Fire doors must be complete with hardware, accessories, and automatic closing device as required by NFPA 80. Indicate on the labels the rating in hours, per NFPA 80, of fire exposure duration. Additionally, ensure a letter follows the hourly rating to designate the location for which the assembly is designed and the temperature rise on the unexposed door face at the end of 30 minutes of fire exposure is required. The construction details necessary for labeled doors take precedence over details indicated or specified for non-labeled doors.

Provide and attach metal UL labels to the bottom bar.

2.1.2.3 Oversized Coiling Fire-rated Door Assemblies

Where fire-rated doors and frames exceed the size for which testing and labeling services are offered, furnish certificates of inspection from either UL, Factory Mutual or Warnock Hersey. State within certificates that except for size; doors, frames, and hardware are identical in design, materials, and construction to a door that has been tested and rated.

2.1.2.4 Operational Cycle Life

Design all portions of the door, hardware and operating mechanism that are subject to movement, wear, or stress fatigue to operate through a minimum number of 10 cycles per day. One complete cycle of door operation is defined as when the door is in the closed position, moves to the fully open position, and returns to the closed position.

2.2 COMPONENTS

2.2.1 Overhead Coiling Doors

2.2.1.1 Curtain Materials and Construction

Provide curtain slats fabricated from Grade A steel sheets conforming to ASTM A653/A653M, with the additional requirement of a minimum yield point of 33,000 psi. Provide minimum 22 gauge sheets, Grade 40 steel with galvanized steel zinc coating in conformance with ASTM A653/A653M and ASTM A924/A924M. Provide steel curtain slats containing a minimum of 20 percent recycled content. Submit data identifying percentage of recycled content for steel curtain slats.

OR

Provide curtain slats fabricated from aluminum sheets conforming to ASTM B209, or ASTM B221 extrusions, alloy and tempering standard from the manufacturer for type of use and finish indicated; with a thickness as required by the size of the door to meet the required windload.

Fabricate doors from interlocking cold-rolled slats, with section profiles as specified, designed to withstand the specified wind loading. Ensure the provided slats are continuous without splices for the width of the door.

Provide exterior doors with slats filled with thermal insulation, complying with the maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84. Enclose the insulation completely within the slat faces on the interior surface of the slats.

2.2.1.2 Non-Insulated Curtains

Form curtains from the manufacturer's standard shapes of interlocking slats.

2.2.1.3 Insulated Curtains

Form curtains from manufacturer's standard shapes of interlocking slats. Supply a slat system with a minimum R-value of 4 when calculated in accordance with ASHRAE FUN IP. Slats to consist of a urethane or polystyrene core not less than 11/16 inch thick, completely enclosed within metal facings. Slat steel thickness as required by the size of the door to meet specified performance requirements. The insulated slat assembly requires a flame spread rating of not more than 25 and a smoke development factor of not more than 50 when tested in accordance with ASTM E84.

2.2.1.4 Curtain Bottom Bar

Install curtain bottom bars as pairs of angles or using extrusions from the manufacturer's standard steel, stainless and aluminum extrusions not less than 2.0 by 2.0 inches by 0.188 inch. Do not use aluminum on doors more than 16 feet wide. Ensure steel extrusions conform to ASTM A36/A36M. Stainless steel extrusions conforming to ASTM A666, Type 304. Aluminum extrusions conforming to ASTM B221. Galvanize angles and fasteners in accordance with ASTM A653/A653M and ASTM A924/A924M. Coat welds and abrasions with paint conforming to ASTM A780/A780M.

2.2.1.5 Endlocks (and Windlocks)

Provide endlocks of Grade B cast steel conforming to ASTM A47/A47M, galvanized in accordance with ASTM A153/A153M. Secure locks at every other curtain slat. In addition to endlocks, exterior doors which have a design wind load of more than 20 pounds per square foot, must have windlocks of manufacturer's standard design. Windlocks must prevent curtain from leaving guide because of deflection from wind pressure or other forces.

2.2.1.6 Weather Stripping

Provide a hood baffle inside the hood that is a minimum 1/16 inch thick sheet of vinyl, neoprene rubber or equivalent. Provide guide weather stripping that is a minimum 1/16 inch thick sheet of vinyl, neoprene rubber, or equivalent.

Provide bottom bar weather-stripping that is a minimum 1/16 inch thick sheet of vinyl, neoprene rubber, or equivalent.

2.2.1.7 Locking Devices

Ensure that the slide bolt engages through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

Provide a locking device assembly which includes cylinder lock, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

2.2.1.8 Safety Interlock

Equip power-operated doors with a safety interlock switch to disengage power supply when the door is locked, or provide an operator with an internal lock sensing device to prevent the door opening when the door is locked.

2.2.2 Hardware

Ensure that all hardware conforms to ASTM A153/A153M, ASTM A307, and ASTM F568M.

2.2.2.1 Guides

Fabricate curtain jamb guides from the manufacturer's standard angles or channels of same material and finish as curtain slats unless otherwise indicated. Provide guides with sufficient depth or incorporate a steel locking bar to retain the curtain in place under the wind pressure specified. Ensure curtain operates smoothly. Slot bolt holes for track adjustment. Securely attach guides to adjoining construction with not less than 3/8 inch diameter bolts, spaced near each end and not over 30 inches apart.

For exterior doors fabricate with structural steel angles. Provide windlock bars of same material when windlocks are required to meet specified wind load. Flare the top of inner and outer guide angles outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and

bottom bar.

2.2.2.2 Hood

Provide a hood with a minimum 24-gauge steel, aluminum 18-gauge B&S, or galvanized sheet metal, flanged at top for attachment to header and flanged at bottom to provide longitudinal stiffness. The hood encloses the curtain coil and counterbalance mechanism.

2.2.3 Counterbalancing Mechanism

Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted, around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed or self-lubricating bearings for rotating members.

2.2.3.1 Brackets

Provide the manufacturer's standard mounting brackets with one located at each end of the counterbalance barrel conforming to ASTM A36/A36M. Provide brackets of hot-rolled steel.

2.2.3.2 Counterbalance Barrels

Curtain must roll up on a barrel supported at head of opening on brackets and be balanced by a torsion spring system in the barrel. Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, conforming to ASTM A53/A53M or equivalent. Ensure the barrel is of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats. Limit barrel deflection to not more than 0.03 inch per foot of span under full load.

a. Barrel

Provide steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot of width.

b. Spring Balance

Provide an oil-tempered, heat-treated steel helical torsion spring assembly designed for proper balance of door. Ensure that effort to operate manually operated units does not exceed 25 lbs. At least 80 percent of the door weight must be counterbalanced at any position. Provide wheel for applying and adjusting spring torque.

2.2.3.3 Torsion Rod for Counter Balance

Fabricate rod from the manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

2.2.4 Electric Door Operators

Provide electrical wiring and door operating controls conforming to the applicable requirements of NFPA 70 and UL 325. The door manufacturer must furnish automatic control and safety devices, including extra flexible type SO cable and spring-loaded automatic takeup reel or equivalent device, as required for proper operation of the doors. Conduit, wiring,

and mounting of controls are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

Electric door-operator assemblies need to be the sizes and capacities recommended and provided by the door manufacturer for specified doors. Furnish complete assemblies with electric motors and factory-prewired motor controls, starter, gear reduction units, solenoid-operated brakes, clutch, remote-control stations, manual or automatic control devices, and accessories as required for proper operation of the doors.

Design the operators so that motors may be removed without disturbing the limit-switch adjustment and affecting the emergency auxiliary operators.

Provide a manual operator of crank-gear or chain-gear mechanisms with a release clutch to permit manual operation of doors in case of power failure. Arrange the emergency manual operator so that it may be put into and out of operation from floor level, and its use does not affect the adjustment of the limit switches. Provide an electrical or mechanical device that automatically disconnects the motor from the operating mechanism when the emergency manual operating mechanism is engaged.

2.2.4.1 Door-Operator Types

Provide an operator mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.

2.2.4.2 Electric Motors

Provide motors which are the high-starting-torque, reversible, constant-duty electrical type with overload protection of sufficient torque and horsepower to move the door in either direction from any position. Ensure they produce a door-travel speed of not less than 8 nor more than 12 inches per second without exceeding the horsepower rating.

Provide motors which conform to NEMA MG 1 designation, temperature rating, service factor, enclosure type, and efficiency to the requirements specified. Motors must be suitable for operation on current of the characteristics indicated. Install motors in approved locations.

2.2.4.3 Motor Bearings

Select bearings with bronze-sleeve or heavy-duty ball or roller antifriction type with full provisions for the type of thrust imposed by the specific duty load.

Pre-lubricate and factory seal bearings in motors less than 1/2 horsepower.

Equip motors coupled to worm-gear reduction units with either ball or roller bearings.

Equip bearings in motors 1/2 horsepower or larger with lubrication service fittings. Fit lubrication fittings with color-coded plastic or metal dust caps.

In any motor, bearings that are lubricated at the factory for extended duty periods do not need to be lubricated for a given number of operating

hours. Display this information on an appropriate tag or label on the motor with instructions for lubrication cycle maintenance.

2.2.4.4 Motor Starters, Controls, and Enclosures

Provide each door motor with: a factory-wired, unfused, disconnect switch; a reversing, across-the-line magnetic starter with thermal overload protection; 24-volt operating coils with a control transformer limit switch; and a safety interlock assembled in a NEMA ICS 6 type enclosure as specified herein. Ensure control equipment conforms to NEMA ICS 1 and NEMA ICS 2.

Provide adjustable switches, electrically interlocked with the motor controls and set to stop the door automatically at the fully open and fully closed position.

2.2.4.5 Control Enclosures

Provide control enclosures that conform to NEMA ICS 6 for general purpose NEMA Type 1.

2.2.4.6 Transformer

Provide starters with 230/460 to 115 volt control transformers with one secondary fuse when required to reduce the voltage on control circuits to 24volts or less. Provide a transformer conforming to NEMA ST 1.

2.2.4.7 Sensing-Edge Device

Provide each door with a pneumatic or electric sensing device that meets UL 325, extends the full width of the door, and is located within a U-section neoprene or rubber astragal, mounted on the bottom rail of the bottom door section. Device needs to immediately stop and reverse the door upon contact with an obstruction in the door opening or upon failure of the device or any component of the control system and cause the door to return to its user-defined open position. Any momentary door-closing circuit must be automatically locked out and the door must be operable manually or with constant pressure controls until the failure or damage has been corrected. A sensing device is not a substitute for a limit switch.

Connect sensing device to the control circuit through a retracting cord and reel.

2.2.4.8 Remote-Control Stations

Remote control stations must be at least 5 feet above the floor line, and all switches must be located so that the operator will have complete visibility of the door at all times. Provide interior remote control stations that are full-guarded, momentary-contact three-button, heavy-duty, surface-mounted NEMA ICS 6 type enclosures as specified. Mark buttons "OPEN," "CLOSE," and "STOP." The "OPEN" and "STOP" buttons must be of the type requiring only momentary pressure to operate. The "CLOSE" button must be of the type either requiring constant pressure to maintain the closing motion of the door or momentary pressure when installed with a monitored entrapment detection device which, upon failure of the device or any component of the control system, cause the door to return to its full open position. When the door is in motion and the "STOP" button is pressed, ensure the door stops instantly and remains in the stopped

position. From the stopped position, the door may then be operated in either direction by the "OPEN" or "CLOSE" buttons. When the door is in motion, and the "CLOSE" button of the constant pressure type is released, the door must stop and remain in the stop position or reverse to the user set up position; from the stop position, the door may then be operated in either direction by the "OPEN" or "CLOSE" buttons. Controls must be adjustable to automatically stop the doors at their fully open and closed positions. Open and closed positions must be readily adjustable.

2.2.4.9 Speed-Reduction Units

Provide speed-reduction units consisting of hardened-steel worm and bronze worm gear assemblies or planetary gear reducers running in oil or grease and inside a sealed casing, coupled to the motor through a flexible coupling. Drive shafts need to rotate on ball- or roller-bearing assemblies that are integral with the unit.

Provide minimum ratings of speed reduction units in accordance with AGMA provisions for class of service.

Ground worm gears to provide accurate thread form; machine teeth for all other types of gearing. Surface harden all gears.

Provide antifriction type bearings equipped with oil seals.

2.2.4.10 Chain Drives

Provide roller chains that are a power-transmission series steel roller type conforming to ASME B29.400, with a minimum safety factor of 10 times the design load.

Heat-treat or otherwise harden roller-chain side bars, rollers, pins, and bushings.

Provide high-carbon steel chain sprockets with machine-cut hardened teeth, finished bore and keyseat, and hollow-head setscrews.

2.2.4.11 Brakes

Provide 360-degree shoe brakes or shoe and drum brakes. Ensure the brakes are solenoid-operated and electrically interlocked to the control circuit to set automatically when power is interrupted.

2.2.4.12 Clutches

Ensure clutches are friction type or adjustable centrifugal type.

2.2.4.13 Weather/Smoke Seal Sensing Edge

Provide automatic stop control by an automatic sensing switch within neoprene astragal extending the full width of door bottom bar.

Provide an electric sensing edge device. Ensure the door immediately stops downward travel when contact occurs before door fully closes. Provide a self-monitoring sensing edge connection to the motor operator.

2.2.5 Fire-Rated Door Assembly

Provide fire-rated door assemblies with the dimensions, fire rating, and

operating type indicated with electric operators and assemblies that do not interfere with manufacturer's standard interconnecting fusible links. Equip fire doors with an automatic closing mechanism. Doors must be forced into a closed position at a rate of descent of not more than 2 feet per second and not less than 6 inches per second without impact. The curtain must be held against the sill until the release mechanism has been reset. The automatic closing mechanism must not interfere with normal operation of the door.

2.2.5.1 Fire Ratings

Provide fire-rated door assemblies complying with NFPA 80 Standard for Fire Doors and Other Opening Protectives. Fire doors must be complete with hardware, accessories, and automatic closing device as required by NFPA 80.

2.2.6 Surface Finishing

Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Noticeable variations in the same metal component are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

Door finish shall be either factory finished painted or painted in the field. Exterior doors shall be a color that matches the other exterior trim features of the building, i.e. downsputs, exterior personnel doors, roof trim, etc. Interior side of the door can be white, galvanized/aluminim color, or the same color as the exterior color.

2.2.6.1 Galvanized and Shop-Primed Finish

Surfaces specified must have a zinc coating, a phosphate treatment, and a shop prime coat of rust-inhibitive paint. The galvanized coating must conform to ASTM A653/A653M, coating designation Z275 (G90), for steel sheets, except that hoods located on interior of the building may be Z180 (G60), and ASTM A123/A123M for iron and steel products. The weight of coatings for products must be as designated in Table I of ASTM A123/A123M for the thickness of base metal to be coated. The prime coat must be a type especially developed for materials treated by phosphates and adapted to application by dipping or spraying. Repair damaged zinc-coated surfaces by the materials and methods conforming to ASTM A780/A780M and spot prime. At the option of the Contractor, a two-part system including bonderizing, baked-on epoxy primer, and baked-on enamel top coat may be applied to slats and hoods before forming, in lieu of prime coat specified.

2.2.6.2 Baked-Enamel or Powder-Coat Finish

Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with the coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 EXECUTION

3.1 INSTALLATION

Install overhead coiling door assembly, anchors and inserts for guides,

brackets, motors, switches, hardware, and other accessories in accordance with approved detail drawings and manufacturer's written instructions. Upon completion of installation, ensure doors are free from all distortion.

Install overhead coiling doors, motors, hoods, and operators at the mounting locations as indicated for each door in the Contract Documents and as required by the manufacturer.

Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility and as required by the manufacturer.

3.1.1 Field Painted Finish

Ensure field painted steel doors and frames are in accordance with Section 09 90 00 PAINTS AND COATINGS and the manufacturer's written instructions. Protect the weather stripping from paint. Ensure that the finishes are free of scratches or other blemishes.

3.2 ADJUSTING AND CLEANING

3.2.1 Acceptance Provisions

After installation, adjust the hardware and moving parts. Lubricate bearings and sliding parts as recommended by manufacturer to provide smooth operating functions for ease movement, free of warping, twisting, or distortion of the door assembly.

Adjust seals to provide a weather-tight fit around entire perimeter.

Engage a factory-authorized service representative to perform startup service and checks according to the manufacturer's written instructions.

Test the door opening and closing operation when activated by controls or alarm-connected fire-release system as applicable. Adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Reset the door-closing mechanism after a successful test.

Test and make final adjustment of new doors at no additional cost to the Government.

3.2.1.1 Maintenance and Adjustment

Not more than 90 calendar days after completion and acceptance of the project, examine, lubricate, test, and re-adjust doors as required for proper operation.

3.2.1.2 Cleaning

Clean doors in accordance with manufacturer's approved instructions.

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SECTION 08 51 13

ALUMINUM WINDOWS
05/19

PART 1 GENERAL

This specification is for the exterior window.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
AAMA/WDMA/CSA 101/I.S.2/A440	(2017) North American Fenestration Standard/Specification for Windows, Doors, and Skylights

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 169	(2013) Climate Data for Building Design Standards

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2020) Procedure for Determining Fenestration Product U-Factors
NFRC 200	(2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G"classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Windows; G, DO

Recycled Content of Aluminum Windows;

Window Performance; G, DO

Accessories;

SD-04 Samples

Finish Sample; G, DO

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Manufacturer

Window manufacturer must specialize in designing and manufacturing the type of aluminum windows specified in this section, and have a minimum of 10 years of documented successful experience. Manufacturer must have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.3.2 Sample Requirements

1.3.2.1 Finish Sample Requirements

Submit color chart of standard factory color coatings.

1.3.3 Design Data Requirements

Submit calculations to substantiate compliance with deflection requirements. A registered Professional Engineer must provide calculations.

Submit calculations showing that the design of each different size and type of aluminum window unit and its anchorage to the structure. Calculations verifying the structural performance of each window proposed for use, under the given loads, must be prepared and signed by a registered professional engineer. Reflect the window components and anchorage devices to the structure, as determined by the design analysis, in the shop drawings.

1.3.4 Certification

Ensure that construction is performed with products that meet or exceed Energy Star criteria, .

Window unit must bear the AAMA Label warranting that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440. Certified test reports attesting that the prime window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440, including test size, will be acceptable in lieu of product labeling.

1.4 DELIVERY AND STORAGE

Deliver windows to project site in an undamaged condition. Use care in handling and hoisting windows during transportation and at the jobsite. Store windows and components out of contact with the ground, under a weathertight covering, so as to prevent bending, warping, or otherwise damaging the windows. Repair damaged windows to an "as new" condition as

approved. If windows can not be repaired, provide a new unit.

1.5 PERFORMANCE REQUIREMENTS

1.5.1 Wind Loading Design Pressure

Design window components, including mullions, hardware, and anchors, to withstand a wind-loading design pressure of at least 30 pounds per square foot (psf).

1.5.2 Tests

Test windows proposed for use in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for the particular type and quality window specified.

Perform tests by a nationally recognized independent testing laboratory equipped and capable of performing the required tests. Submit the results of the tests as certified laboratory reports required herein.

Minimum design load for a uniform-load structural test must be 50 psf.

1.6 DRAWINGS

1.7 WINDOW PERFORMANCE

Aluminum windows must meet the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

1.7.1 Structural Performance

Structural test pressures on window units must be for positive load (inward) and negative load (outward). After testing, there will be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There must be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA/WDMA/CSA 101/I.S.2/A440 for the window types and classification specified in this section.

1.7.2 Air Infiltration

Air infiltration must not exceed the amount established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

1.7.3 Water Penetration

Water penetration must not exceed the amount established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

1.7.4 Thermal Performance

Windows (including frames and glass) will be independently tested and certified with a Solar Heat Gain Coefficient (SHGC) determined according to NFRC 200 procedures and a whole window U-factor determined in accordance with NFRC 100 within the ranges as indicated below according to the ASHRAE 169 Climate Zone of the project location.

1.8 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 WINDOWS

Provide prime windows that comply with AAMA/WDMA/CSA 101/I.S.2/A440 and the requirements specified herein. In addition to compliance with AAMA/WDMA/CSA 101/I.S.2/A440, window framing members for each individual light of glass must not deflect to the extent that deflection perpendicular to the glass light exceeds L/175 of the glass edge length when subjected to uniform loads at specified design pressures. rovide windows of types, performance classes, performance grades, combinations, and sizes indicated or specified. Provide aluminum window frames with a minimum recycled content of 20 percent. Provide data identifying percentage of recycled content of aluminum windows. Design windows to accommodate glass, weatherstripping, and accessories to be furnished. Each window must be a complete factory assembled unit with glass installed. Dimensions shown are minimum.

2.1.1 Fixed Windows (F)

Type F- AW40 .

2.1.2 Glass and Glazing

Materials are specified in Section 08 81 00 GLAZING.

2.1.3 Caulking and Sealing

Are specified in Section 07 92 00 JOINT SEALANTS.

2.2 FABRICATION

Fabrication of window units must comply with AAMA/WDMA/CSA 101/I.S.2/A440.

2.2.1 Provisions for Glazing

Design windows and rabbets suitable for glass thickness shown or specified. Design sash for outside glazing and for securing glass with glazing channels, or glazing compound.

2.2.2 Fasteners

Use window manufacturer's standard for windows, trim, and accessories. Self-tapping sheet-metal screws are not acceptable for material more than 1/16 inch thick.

2.2.3 Adhesives

Provide joint sealants as specified in Section 07 92 00 JOINT SEALANTS. For interior application of joint sealants, comply with applicable regulations regarding reduced VOC's, and as specified in Section 07 92 00 JOINT SEALANTS.

2.2.4 Drips and Weep Holes

Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, drips must be continuous across tops of fixed windows. Provide drips and weep holes as required to return water to the outside.

2.2.5 Accessories

Provide windows complete with necessary fastenings, clips, fins, anchors, glazing beads, and other appurtenances necessary for complete installation and proper operation. Furnish extruded aluminum subframe receptors and subsill with each window unit.

2.2.5.1 Fasteners

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Anchors and fasteners must be compatible with the window and the adjoining construction. Provide a minimum of three anchors for each jamb located approximately 6 inches from each end and at midpoint.

2.2.5.2 Window Anchors

Anchoring devices for installing windows must be made of aluminum, cadmium-plated steel, stainless steel, or zinc-plated steel conforming to AAMA/WDMA/CSA 101/I.S.2/A440.

2.2.6 Finishes

Comply with NAAMM's "Metal Finishes Manual" for applying and designating finishes. Exposed aluminum surfaces must be factory finished with an organic coating. Color must be as indicated.

2.2.6.1 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a high-performance finish in accordance with AAMA 2605 with total dry film thickness of not less than 1.2 mils.

2.3 THERMAL-BARRIER WINDOWS

Provide thermal-barrier windows, complete with accessories and fittings.

Specify material and construction except as follows:

a. Aluminum alloy must be 6063-T6.

b. Frame construction, including operable sash, must be factory-assembled and factory-sealed inner and outer aluminum completely separated from metal-to-metal contact. Join assembly by a continuous, concealed, low conductance divider housed in an interlocking extrusion of the inner frame. Metal fasteners, straps, or anchors must not bridge the connection between the inner and outer frame.

Must be factory-glazed with the type of glass indicated and of the quality specified in Section 08 81 00 GLAZING.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Method of Installation

Install in accordance with the window manufacturer's printed instructions and details. Build in windows as the work progresses or install without forcing into prepared window openings. Set windows at proper elevation, location, and reveal; plumb, square, level, and in alignment; and brace, strut, and stay properly to prevent distortion and misalignment. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes in mastic sealant of a type recommended by the window manufacturer. Install and caulk windows in a manner that will prevent entrance of water and wind.

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.1.2 Dissimilar Materials

Where aluminum surfaces are in contact with, or fastened to masonry, concrete, wood, or dissimilar metals, except stainless steel or zinc, protect the aluminum surface from dissimilar materials as recommended in the Appendix to AAMA/WDMA/CSA 101/I.S.2/A440. Do not coat surfaces in contact with sealants after installation with any type of protective material. Do not apply coatings or lacquers to surfaces to which caulking and glazing components must adhere.

3.1.3 Anchors and Fastenings

Make provision for securing units to each other, to masonry, and to other adjoining construction. Windows installed in masonry walls must have head and jamb members designed to recess into masonry wall not less than 7/16 inch.

3.2 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weather-stripping, and to prevent interference with the operation of hardware. Replace all stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

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PART 3 EXECUTION

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SECTION 08 51 23

STEEL WINDOWS
08/20, CHG 1: 02/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.6.3	(2024) Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(2022) Standard for Fire Doors and Other Opening Protectives
NFPA 101	(2024) Life Safety Code

STEEL WINDOW INSTITUTE (SWI)

SWI SWS	(2017; R 2018) Steel Window Specifications

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Window; G, DO

Recycled Content for Steel Framing Materials

SD-04 Samples

Color Coating; G, DO

1.3 QUALITY ASSURANCE

1.3.1 Color Coating Samples Information

Submit chart of manufacturer's color coatings if factory finish is to be provided in lieu of field painting.

1.4 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

1.5 DELIVERY AND STORAGE

Deliver to project site in undamaged condition. Store windows and components on edge, out of contact with the ground, under weathertight covering, and arranged to avoid bending, warping, or other damage.

PART 2 PRODUCTS

This specification is for the interior fire rated window.

2.1 MATERIALS

2.1.1 General System Requirements

Steel framing materials must contain a minimum of 40 percent total recycled content. Provide data identifying percentage of recycled content for steel framing materials.

2.1.2 Steel Bars

SWI SWS.

2.1.3 Sheet Steel

ASTM A1011/A1011M.

2.1.4 Zinc-Coated Sheet Steel

ASTM A653/A653M.

2.1.5 Zinc Coating

ASTM A123/A123M.

2.1.6 Screws and Bolts

ASME B18.6.3 as applicable.

2.2 FABRICATION OF WINDOW

Form permanent joints by welding or mechanically fastening as specified for each type window. Use joints of strength to maintain structural value of members connected. Weld joints solid, remove excess metal, and dress smooth on exposed and contact surfaces. Closely fit joints formed with mechanical fastenings and make permanently watertight. Assemble frames with glazing at the plant and ship as a unit. Provide the following construction:

a. Design glazed windows and rabbets suitable for glass thickness as required to meet fire rating.

b. Use flathead, cross recessed type, exposed head screws and bolts with standard threads on windows, trim and accessories. Screw heads must finish flush with adjoining surfaces. Self tapping sheet-metal screws are not acceptable.

c. For hot-dipped galvanized windows, use stainless steel or hot-spun galvanized steel fasteners. For windows with painted finish use electro-galvanized fasteners. Finish exposed heads to match finish of windows.

2.3 FIRE RATED WINDOWS

Provide sash and frame with necessary hardware to conform to the requirements of Underwriters Laboratories Inc. (UL), for class/fire-rating of window indicated. Submit proof of conformance. UL label will be accepted as proof. Labeled window details take precedence over details indicated or specified for nonlabeled windows, except when sections required for nonlabeled windows are heavier than those required by UL. In lieu of UL label, written certification by approved nationally recognized testing agency may be submitted. Certification must state that complete window unit of type provided has been tested and conforms to published standards, including methods of tests, of UL. Glazing shall be provided as a unit with the frame.

2.4 ACCESSORIES

Provide windows with clips, fins, anchors, glazing beads, and fastenings, necessary for complete installation and operation of ventilators.

2.4.1 Anchors

Use hot-dip galvanized steel anchors. Secure anchors and fastenings to heads, jambs, and sills of openings, and fasten securely to windows or frames. Use anchors recommended by window manufacturer for specific type of construction and conceal. Anchor each frame at jambs with minimum of three adjustable steel anchors.

2.4.2 Fasteners

Prime exposed heads of coated or plated fasteners and finish to match adjacent material.

2.4.3 Metal Sub-frames and Stools

Manufacturer's standard type designed to suit the particular window. Match exposed surfaces to windows.

2.5 WINDOW FINISH

2.5.1 Shop Primed Finish

After fabrication, clean all surfaces of windows, fins, mullions, cover plates, and screen frames and provide a hot-dip galvanized, phosphate-treated and shop primed finish. Conform to SWI SWS for the methods of cleaning, chemical treatment, galvanizing, and painting.

2.5.2 Factory Finish

In lieu of shop primed finish, factory finish may be provided using the following method, in which case finish field painting will not be required:

a. Chemically clean and bonderize windows. Apply dip coat of epoxy primer baked on for not less than 15 minutes at not less than 300 degrees F, followed by finish coat of alkyd-amine enamel of not less than one mil thickness, baked on for 15 minutes at not less than 300 degrees F.

b. Finish color coating to be selected from manufacturer's standard color chart.

c. Touch up abraded surfaces with enamel as specified for factory finish.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with window manufacturer's printed instructions and details. Install fire rated windows in accordance with NFPA 80 and NFPA 101. Build in windows as work progresses or install without forcing into prepared window openings. Set at proper elevation, location, and reveal; plumb, square, level, and in alignment. Brace and stay to prevent distortion and misalignment. Bed screws or bolts in sill members, contacts of windows with sills, built-in fins, and subframes in mastic sealant recommended by window manufacturer.

Any materials that show visual evidence of rust shall not be installed on the building project.

3.2 ANCHORS AND FASTENINGS

Make provision for securing units to adjoining construction. Space anchors not more than 18 inches apart on jambs and sills, and install a minimum of three anchors on each side of each opening. Anchors and fastenings must have sufficient strength to hold member firmly in position. Where type, size, or spacing of anchors is not shown or specified, use expansion or toggle bolts or screws as best suited to construction material. Provide expansion shield and bolt assemblies of type designed to give holding power beyond tensile and shearing strength of bolt. Minimum fastener penetration must be not less than that recommended by manufacturer for type fastener and wall material involved.

3.3 CLEANING

Clean surfaces of window unit of mortar, plaster, paint spattering spots,

and other foreign matter to present a neat appearance. Clean and touch up abraded surfaces. Replace with new windows any stained, discolored, or abraded windows that cannot be restored to original condition.

-- End of Section --

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SECTION 08 71 00

DOOR HARDWARE
02/16, CHG 4: 02/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E283	(2019) Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.1	(2021) Butts and Hinges
ANSI/BHMA A156.2	(2022) Bored and Preassembled Locks and Latches
ANSI/BHMA A156.3	(2020) Exit Devices
ANSI/BHMA A156.4	(2013) Door Controls - Closers
ANSI/BHMA A156.5	(2020) Cylinder and Input Devices for Locks
ANSI/BHMA A156.7	(2016) Template Hinge Dimensions
ANSI/BHMA A156.8	(2021) Door Controls - Overhead Stops and Holders
ANSI/BHMA A156.13	(2022) Mortise Locks & Latches Series 1000
ANSI/BHMA A156.16	(2018) Auxiliary Hardware
ANSI/BHMA A156.18	(2020) Materials and Finishes
ANSI/BHMA A156.21	(2019) Thresholds
ANSI/BHMA A156.22	(2021) Gasketing

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 80	(2022) Standard for Fire Doors and Other Opening Protectives

NFPA 101	(2024) Life Safety Code
NFPA 252	(2022) Standard Methods of Fire Tests of Door Assemblies

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8	(2023) Specifications for Standard Steel Doors and Frames

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

UL SOLUTIONS (UL)

UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Hardware Schedule; G, DO

Keying System; G, RO

SD-03 Product Data

Hardware Items; G, DO

SD-08 Manufacturer's Instructions

Installation

SD-10 Operation and Maintenance Data

Hardware Schedule Items, Data Package 1

SD-11 Closeout Submittals

Key Bitting

1.3 PRODUCT DATA

Indicate fire-ratings at applicable components. Provide documentation of ABA/ADA accessibility compliance of applicable components, as required by 36 CFR 1191 Appendix D - Technical.

1.4 HARDWARE SCHEDULE

Provide Hardware Item List and Hardware Schedule containing the following information, and additional information as needed to identify the complete make up of each hardware set and its application to each opening:

1.4.1 Hardware Item List:

a. Hardware Type

b. Item Number

c. Quantity

d. Size(s)

e. Reference Publication / Type Number

f. Manufacturer's Name / Catalog Number

g. Key Control Symbols

h. UL Mark (If fire rated and listed)

i. BHMA Finish(es)

j. Remarks

1.4.2 Hardware Schedule

a. Hardware Set Number

b. Opening Number(s)

c. Opening Description (single/double leaf, hand, size, door/frame material)

d. Fire Rating

Hardware Items

f. Quantity

g. Size

h. BHMA Finish

i. Remarks

In addition, submit hardware schedule data package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5 KEY BITTING CHART REQUIREMENTS

1.5.1 Requirements

Submit key bitting charts to the Contracting Officer prior to completion of the work. Include:

a. Complete listing of all keys (e.g. AA1 and AA2).

b. Complete listing of all key cuts (AA1-123456, AA2-123458).

c. Tabulation showing which key fits which door.

d. Copy of floor plan showing doors and door numbers.

e. Listing of 20 percent more key cuts than are presently required in each master system.

1.6 QUALITY ASSURANCE

1.6.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges, and closers of one lock, hinge, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

1.6.2 Key Shop Drawings Coordination Meeting

Prior to the submission of the key shop drawing, the Contracting Officer, Contractor, Door Hardware Subcontractor, using Activity and Base Locksmith must meet to discuss and coordinate key requirements for the facility.

1.7 DELIVERY, STORAGE, AND HANDLING

Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown on hardware schedule. Deliver permanent keys and removable cores to the Contracting Officer. Deliver construction master keys with the locks.

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

Hardware applied to metal doors must be manufactured using a template. Provide templates to door and frame manufacturers in accordance with ANSI/BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS

Provide all hardware necessary to meet the requirements of NFPA 72 for door alarms, NFPA 80 for fire doors, NFPA 101 for exit doors, NFPA 252 for fire tests of door assemblies, ABA/ADA accessibility requirements, and all other requirements indicated, even if such hardware is not specifically mentioned in paragraph HARDWARE SCHEDULE. Provide Underwriters Laboratories, Inc. labels for such hardware in accordance with UL Bld Mat Dir or equivalent labels in accordance with another testing laboratory approved in writing by the Contracting Officer.

2.3 HARDWARE ITEMS

Clearly and permanently mark with the manufacturer's name or trademark, hinges, pivots, locks, latches, exit devices, bolts and closers where the identifying mark is visible after the item is installed. For closers with

covers, the name or trademark may be beneath the cover.

2.3.1 Hinges

Provide in accordance with ANSI/BHMA A156.1. Provide hinges that are 4-1/2 by 4-1/2 inch unless otherwise indicated. Construct loose pin hinges for interior doors and reverse-bevel exterior doors so that pins are non-removable when door is closed. Other anti-friction bearing hinges may be provided in lieu of ball bearing hinges.

2.3.2 Locks and Latches

2.3.2.1 Mortise Locks and Latches

Provide in accordance with ANSI/BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 2. Provide mortise locks with escutcheons not less than 7 by 2-1/4 inch with a bushing at least 1/4 inch long. Cut escutcheons to fit cylinders and provide trim items with straight, beveled, or smoothly rounded sides, corners, and edges. Provide knobs and roses of mortise locks with screwless shanks and no exposed screws.

2.3.2.2 Bored Locks and Latches

Provide in accordance with ANSI/BHMA A156.2, Series 4000, Grade 1.

2.3.2.3 Combination Locks

Heavy-duty, mechanical combination lockset with five push buttons, standard sized levers, 3/4 inch deadlocking latch, 2-3/4 inch backset. Locks to operate by pressing two or more of the buttons in unison or individually in the proper sequence. Inside panic bar operates the latch. Provide a keyed cylinder on the interior to permit setting the combination. Provide a keyed removable core cylinder on the exterior to permit bypassing the combination.

2.3.3 Exit Devices

Provide in accordance with ANSI/BHMA A156.3, Grade 1. Provide adjustable strikes for rim type and vertical rod devices. Provide open back strikes for pairs of doors with mortise and vertical rod devices. Provide crossbars and arms.

2.3.4 Cylinders and Cores

Provide cylinders and cores for locks, including locks provided under other sections of this specification. Provide cylinders and cores with seven pin tumblers. Provide cylinders from the products of one manufacturer, and provide cores from the products of one manufacturer. Rim cylinders, mortise cylinders, and knobs of bored locksets have interchangeable cores which are removable by special control keys. Stamp each interchangeable core with a key control symbol in a concealed place on the core.

2.3.5 Push Button Mechanisms

Provide in accordance with ANSI/BHMA A156.5, Grade 1.

2.3.6 Keying System

Provide a grand master keying system.

2.3.7 Lock Trim

Provide cast, forged, or heavy wrought construction and commercial plain design for lock trim.

2.3.7.1 Lever Handles

Provide lever handles. Provide in accordance with ANSI/BHMA A156.3 for mortise locks of lever handles for exit devices. Provide lever handle locks with a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when force in excess of that specified in ANSI/BHMA A156.13 is applied to the lever handle. Provide lever handles return to within 1/2 inch of the door face.

2.3.8 Keys

Provide one file key, one duplicate key, and one working key for each key change and for each master keying system. Provide one additional working key for each lock of each keyed-alike group. Stamp each key with appropriate key control symbol and "U.S. property - do not duplicate." Do not place room number on keys.

2.3.9 Closers

Provide in accordance with ANSI/BHMA A156.4, Series C02000, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, and other features necessary for the particular application. Size closers in accordance with manufacturer's printed recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty.

2.3.9.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation in locations that will be visible after installation.

2.3.10 Overhead Holders

Provide in accordance with ANSI/BHMA A156.8.

2.3.11 Door Stops and Silencers

Provide in accordance with ANSI/BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair.

2.3.12 Thresholds

Provide in accordance with ANSI/BHMA A156.21. Use J35100, with vinyl or silicone rubber insert in face of stop, for exterior doors opening out, unless specified otherwise.

2.3.13 Weatherstripping Gasketing

Provide in accordance with ANSI/BHMA A156.22. Provide the type and

function designation where specified in paragraph HARDWARE SCHEDULE. Provide a set to include head and jamb seals, sweep strips, and, for pairs of doors, astragals. Air leakage of weatherstripped doors not to exceed 1.25 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283. Provide weatherstripping with one of the following:

2.3.13.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Provide clear (natural) anodized aluminum.

2.3.13.2 Interlocking Type

Zinc not less than 0.018 inch thick.

2.3.13.3 Spring Tension Type

Stainless steel not less than 0.008 inch thick.

2.3.14 Rain Drips

Provide in accordance with ANSI/BHMA A156.22. Provide extruded aluminum rain drips, not less than 0.08 inch thick, clear anodized finish. Provide the manufacturer's full range of color choices to the Contracting Officer for color selection. Provide rain drips with a 4 inch overlap on each side of each exterior door that is not protected by an awning, roof, eave or other horizontal projection. Set drips in sealant and fasten with stainless steel screws.

2.3.14.1 Door Rain Drips

Approximately 1-1/2 inch high by 5/8 inch projection. Align bottom with bottom edge of door.

2.3.14.2 Overhead Rain Drips

Approximately 1-1/2 inch high by 2-1/2 inch projection. Align bottom with door frame rabbet.

2.3.15 Auxiliary Hardware (Other than locks)

Provide in accordance with ANSI/BHMA A156.16, Grade 1.

2.3.16 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, as required to service and adjust hardware items.

2.4 FASTENERS

Provide fasteners of type, quality, size, and quantity appropriate to the specific application. Fastener finish to match hardware. Provide stainless steel or nonferrous metal fasteners in locations exposed to weather. Verify metals in contact with one another are compatible and will avoid galvanic corrosion when exposed to weather.

2.5 FINISHES

Provide in accordance with ANSI/BHMA A156.18. Provide hardware in BHMA 630 finish (satin stainless steel), unless specified otherwise. Provide items not manufactured in stainless steel in BHMA 626 finish (satin chromium plated) over brass or bronze, except aluminum paint finish for surface door closers. Provide hinges in stainless steel with BHMA 630 finish. Furnish exit devices in BHMA 626 finish in lieu of BHMA 630 finish. Match exposed parts of concealed closers to lock and door trim.

PART 3 EXECUTION

3.1 INSTALLATION

Provide hardware in accordance with manufacturers' printed installation instructions. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

3.1.1 Weatherstripping Installation

Provide full contact, weathertight seals that allow operation of doors without binding the weatherstripping.

3.1.1.1 Stop Applied Weatherstripping

Fasten in place with color matched sheet metal screws not more than 9 inch on center after doors and frames have been finish painted.

3.1.1.2 Interlocking Type Weatherstripping

Provide interlocking, self adjusting type on heads and jambs and flexible hook type at sills. Nail weatherstripping to door 1 inch on center and to heads and jambs at 4 inch on center.

3.1.1.3 Spring Tension Type Weatherstripping

Provide spring tension type on heads and jambs. Provide bronze nails with bronze. Provide stainless steel nails with stainless steel. Space nails not more than 1-1/2 inch on center.

3.1.2 Threshold Installation

Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws in expansion sleeves. For aluminum thresholds placed on top of concrete surfaces, coat the underside surfaces that are in contact with the concrete with fluid applied waterproofing as a separation measure prior to placement.

3.2 FIRE DOORS AND EXIT DOORS

Provide hardware in accordance with NFPA 72 for door alarms, NFPA 80 for fire doors, NFPA 101 for exit doors, and NFPA 252 for fire tests of door assemblies.

3.3 HARDWARE LOCATIONS

Provide in accordance with SDI/DOOR A250.8, unless indicated or specified otherwise.

3.4 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, errors in cutting and fitting and damage to adjoining work.

3.5 HARDWARE SETS

HW-1
3 Hinges NRP A2111
1 Mortise cipher lock
1 Exit deivce (surface rods)
1 Closer C02021
1 Threshold
1 Set Weatherstripping R0D165

HW-2
6 Hinges A2111 NRP
1 Mortise cipher lock
1 Exit deivce (surface rods)
1 Closer C02021
2 Flush bolts (top and bottom) on inactive leaf
1 Threshold
1 Set Weatherstripping

HW-3
6 Hinges A2111
1 Mortise latch set F01 (passage)
1 Exit deivce (surface rods)
1 Closer C02021
2 Flush bolts (top and bottom) on inactive leaf
1 set smoke seals

HW-4
3 Hinges A2111
1 Mortise latch set F01 (passage)
1 Exit deivce (surface rods)
1 Closer C02021
1 set smoke seals (if fire rated door)

HW-5
3 Hinges A2111
1 Mortise lock Fxx (keyed)
1 set silencers

HW-6
3 Hinges A2111
1 Bored latch
1 set silencers

HW-7
3 Hinges A2111
1 Bored lock (privacy)
1 set silencers

-- End of Section --

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GLAZING

05/19

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SECTION 08 81 00

GLAZING
05/19

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 800	(2016) Voluntary Specifications and Test Methods for Sealants

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(2015) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM C509	(2006; R 2021) Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C864	(2005; R 2015) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C1021	(2008; R 2014) Standard Practice for Laboratories Engaged in Testing of Building Sealants
ASTM C1036	(2021) Standard Specification for Flat Glass
ASTM C1048	(2018) Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
ASTM C1087	(2016) Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems
ASTM C1172	(2019) Standard Specification for Laminated Architectural Flat Glass

ASTM C1184	(2023) Standard Specification for Structural Silicone Sealants
ASTM C1281	(2016) Standard Specification for Preformed Tape Sealants for Glazing Applications
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D2287	(2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E119	(2022) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E1300	(2016) Standard Practice for Determining Load Resistance of Glass in Buildings
ASTM E2190	(2010) Standard Specification for Insulating Glass Unit Performance and Evaluation

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2008) Glazing Manual
GANA Sealant Manual	(2008) Sealant Manual
GANA Standards Manual	(2008) Engineering Standards Manual

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

IGMA TB-1200	(1983; R 2016) Guidelines for Insulating Glass Dimensional Tolerances
IGMA TB-3001	(2001) Guidelines for Sloped Glazing
IGMA TM-3000	(1990; R 2016) North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 251	(2006) Standard Methods of Tests of Fire Resistance of Building Construction and Materials

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that

will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES and in conjunction with 08 51 13 ALUMINUM WINDOWS frames. 08 51 23 STEEL WINDOWS includes glazing requirements, so this specification does not apply to the steel framed window.

SD-03 Product Data

Insulating Glass; G, DO

Glazing Accessories

Sealants

SD-08 Manufacturer's Instructions

Setting and Sealing Materials

Glass Setting

SD-11 Closeout Submittals

Warranty for Insulated Glass Units

1.3 SYSTEM DESCRIPTION

Fabricate and install watertight and airtight glazing systems to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, or defects in the work. Glazed panels must comply with the safety standards, in accordance with ANSI Z97.1, and comply with indicated wind/snow loading in accordance with ASTM E1300.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not start glazing work until the outdoor temperature is above 40 degrees F and rising, unless procedures recommended by the glass manufacturer and approved by the Contracting Officer are made to warm the glass and rabbet surfaces. Provide ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work during damp or rainy weather.

1.6 WARRANTY

1.6.1 Warranty for Insulated Glass Units

Warranty insulating glass units against development of material obstruction to vision (such as dust, fogging, or film formation on the inner glass surfaces) caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the

Government.

PART 2 PRODUCTS

2.1 GLASS

ASTM C1036, unless specified otherwise. In doors, provide safety glazing material conforming to 16 CFR 1201.

2.1.1 Laminated Glass

ASTM C1172, Laminated glass fabricated from two nominal 1/8 inch pieces of Type I, Class 1, Quality Q3, flat annealed; clear glass conforming to ASTM C1036. Flat glass to be laminated together with a minimum of 0.030 inch inch thick, clear polyvinyl butyral laminate, conforming to requirements of 16 CFR 1201 and ASTM C1172. The total thickness of nominally 1/4 inches. Color to be clear for the narrow lite in the door.

2.1.2 Tempered Glass

ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class 2 (tinted heat absorbing)for the exterior window, Quality q3, 1/4 inch thick, conforming to ASTM C1048 and GANA Standards Manual. Color, light transmittance, and shading coefficient shall be as indicated in paragraph "Tinted, Low-E Insulating Units" where used as the outer pane of insulating glass units .

2.1.3 Fire/Safety Rated Glass

2.1.3.1 Fire Resistive Rated Glazing

Fire resistive glass must be laminated, with intumescent interlayer, Type I transparent flat type, Class 1-clear and meet 16 CFR 1201 Category II (over 9 square feet). Glass must have a 90 minute rating when tested in accordance with ASTM E119 and NFPA 251. Glass must be permanently labeled with appropriate markings.

2.2 INSULATING GLASS UNIT (EXTERIOR WINDOW)

Two panes of glass separated by a dehydrated airspace, filled with argon gas and hermetically sealed, conforming to ASTM E2190. Submit performance and compliance documentation for each type of insulating glass.

Dimensional tolerances must be as specified in IGMA TB-1200. Spacer must be black, roll-formed, thermally broken aluminum, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal must be compressed polyisobutylene and the secondary seal must be a specially formulated silicone.

Interior panes for Low-E insulating units shall be laminated annealed flat glass unless noted otherwise in the design drawings. Exterior panes shall be tinted, tempered glass, with anti-reflective low-emissivity coating on No. 2 surface (inside surface of exterior pane), Quality q3 - glazing select, conforming to ASTM C1036. Glass performance shall be U value maximum of 0.22 Btu/hr-ft2-F (Summer Daytime), Solar Heat Gain Coefficient (SHGC) maximum of 0.23, Visible Light Transmittance minimum of 35 percent. Color shall be gray, matching adjacent buildings.

2.3 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted must be gray or neutral color. Sealant testing must be performed by a testing agency qualified according to ASTM C1021.

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified.

2.3.1 Putty and Glazing Compound

Provide glazing compound as recommended by manufacturer for face-glazing metal sash. Putty must be linseed oil type. Do not use putty and glazing compounds with insulating glass or laminated glass.

2.3.2 Sealants

Provide elastomeric sealants.

2.3.2.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing metal sash. Sealants must be chemically compatible with setting blocks, edge blocks, and sealing tapes, with sealants used in manufacture of insulating glass units. Color of sealant must be white.

2.3.2.2 Structural Sealant

ASTM C1184, Type S.

2.3.3 Glazing Tapes

2.3.3.1 Back-Bedding Mastic Glazing Tapes

Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

a. AAMA 804.3 tape, where indicated.

b. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.

c. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.3.3.2 Expanded Cellular Glazing Tapes

Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.

b. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.3.4 Sealing Tape

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D2287. Use only where glazing rabbet is designed for tape and is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes must be chemically compatible with the product being set.

2.3.5 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks must be dense extruded type conforming to ASTM C509 and ASTM D395, Method B, Shore A durometer between 70 and 90. Edge blocking must be Shore A durometer of 50 (plus or minus 5). Provide silicone setting blocks when blocks are in contact with silicone sealant. Profiles, lengths and locations must be as required and recommended in writing by glass manufacturer.

2.3.6 Glazing Gaskets

Glazing gaskets must be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening must be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets must be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Provide glazing gasket profiles as recommended by the manufacturer for the intended application.

2.3.6.1 Fixed Glazing Gaskets

Fixed glazing gaskets must be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C509, Type 2, Option 1.

2.3.6.2 Wedge Glazing Gaskets

Wedge glazing gaskets must be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C864, Option 1, Shore A durometer between 65 and 75.

2.3.6.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing must be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

2.3.7 Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers. Use ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to surface.

PART 3 EXECUTION

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

3.1 PREPARATION

Preparation, unless otherwise specified or approved, must conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.2 GLASS SETTING

Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, must conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Aluminum windows, wood doors, and wood windows may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

3.2.1 Insulating Glass Units

Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation must conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.

3.2.2 Installation of Heat-Absorbing Glass

Provide glass with clean-cut, factory-fabricated edges. Field cutting will not be permitted.

3.2.3 Installation of Laminated Glass

Sashes which are to receive laminated glass must be weeped to the outside to allow water drainage into the channel.

3.3 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass must be clean at the time the work is accepted.

3.4 PROTECTION

Protect glass work immediately after installation. Identify glazed openings with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Protect reflective glass with a protective material to eliminate any contamination of the reflective coating. Place protective material far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Upon removal, separate protective materials for reuse or recycling. Remove and replace glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities with new units.

-- End of Section --

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SECTION 08 91 00

METAL WALL LOUVERS

08/20

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-- End of Section Table of Contents --

SECTION 08 91 00

METAL WALL LOUVERS
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-L	(2015) Laboratory Methods of Testing Louvers for Rating
AMCA 511	(2010; R 2016) Certified Ratings Program for Air Control Devices

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 2605	(2020) Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wall Louvers; G, DO

SD-03 Product Data

Metal Wall Louvers; G, DO

SD-04 Samples

Wall Louver Color Samples; G, DO

1.3 DELIVERY, STORAGE, AND PROTECTION

Deliver materials to the site in an undamaged condition. Carefully store materials off the ground to provide proper ventilation, drainage, and protection against dampness. Louvers must be free from nicks, scratches, and blemishes. Replace defective or damaged materials with new.

1.4 DETAIL DRAWINGS

Show all information necessary for fabrication and installation of wall louvers. Indicate materials, sizes, thicknesses, fastenings, and profiles.

1.5 COLOR SAMPLES

Colors of finishes for wall louver color samples must closely approximate colors indicated. Where color is not indicated, submit the manufacturer's standard colors to the Contracting Officer for selection.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Steel Sheet

ASTM A653/A653M, coating designation G90.

2.1.2 Aluminum Sheet

ASTM B209, alloy 3003 or 5005 with temper as required for forming.

2.1.3 Extruded Aluminum

ASTM B221, alloy 6063-T5 or -T52.

2.1.4 Cold Rolled Steel Sheet

ASTM A1008/A1008M, Class 1, with matte finish. Use for interior louvers only.

2.2 METAL WALL LOUVERS

For supply fan intake louvers: Wind driven rain resistant type, with bird screens and made to withstand a wind load of not less than 100 pounds per square foot. Wall louvers must bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500-L and AMCA 511. The louver must meet the Wind Driven Rain Penetration Class "A" and have an effectiveness of 99.9% at a free area velocity of 1500 feet per minute and rainfall rate of 3" per hour. Free area of installed louver shall be no less than 50%.

For all other louvers: Weather resistant type, with bird screens and made to withstand a wind load of not less than 30 pounds per square foot. Wall louvers must bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500-L and AMCA 511. The rating must show a water penetration of 0.20 or less ounce per square foot of free area at a free velocity of 800 feet per minute. Free area of installed louver shall be no less than 50%.

Louvers can be either aluminum or steel as follow but shall be of the same material for all louvers in the project.

2.2.1 Extruded Aluminum Louvers

Fabricated of extruded 6063-T5 or -T52 aluminum with a wall thickness of not less than 0.081 inch.

2.2.2 Formed Metal Louvers

Formed of zinc-coated steel sheet not thinner than 16 U.S. gage, or aluminum sheet not less than 0.08 inch thick.

2.2.3 Mullions and Mullion Covers

Same material and finish as louvers. Provide mullions as required by the manufacturer.. Provide mullion covers on both faces of joints between louvers.

2.2.4 Screens and Frames

For aluminum louvers, provide 1/2 inch square mesh, 14 or 16 gage aluminum or 1/4 inch square mesh, 16 gage aluminum bird screening. Mount screens in removable, rewirable frames of same material and finish as the louvers.

2.3 FASTENERS AND ACCESSORIES

Provide stainless steel screws and fasteners for aluminum louvers and zinc-coated or stainless steel screws and fasteners for steel louvers. Provide other accessories as required for complete and proper installation.

2.4 FINISHES

2.4.1 Aluminum

Exposed aluminum surfaces must be factory finished with an organic coating. Color must be as indicated. Louvers must have the same finish.

2.4.1.1 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a superior performance finish in accordance with AAMA 2605 with total dry film thickness of not less than 1.2 mil.

2.4.2 Steel

Surfaces specified must have a zinc coating, a phosphate treatment, and a shop prime coat of rust-inhibitive paint. The galvanized coating must conform to ASTM A653/A653M, coating designation Z275 (G90). The weight of zinc coatings must be as designated in Table I of ASTM A123/A123M for the thickness of base metal to be coated. The prime coat must be a type especially developed for materials treated by phosphates and adapted to application by dipping or spraying. Repair damaged zinc-coated surfaces by the materials and methods conforming to ASTM A780/A780M and spot prime. At the option of the Contractor, a two-part system including bonderizing, baked-on epoxy primer, and baked-on enamel top coat may be applied before forming, in lieu of prime coat specified.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Wall Louvers

Install using stops or moldings, flanges, strap anchors, or jamb fasteners as appropriate for the wall construction and in accordance with manufacturer's recommendations.

3.1.2 Screens and Frames

Attach frames to louvers with screws or bolts.

3.2 PROTECTION FROM CONTACT OF DISSIMILAR MATERIALS

3.2.1 Copper or Copper-Bearing Alloys

Paint copper or copper-bearing alloys in contact with dissimilar metal with heavy-bodied bituminous paint or separate with inert membrane.

3.2.2 Aluminum

Where aluminum contacts metal other than zinc, paint the dissimilar metal with a primer and two coats of aluminum paint.

3.2.3 Metal

Paint metal in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.2.4 Wood

Paint wood or other absorptive materials that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

-- End of Section --

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SECTION 09 06 00

SCHEDULES FOR FINISHES
08/22

PART 1 GENERAL

1.1 SUMMARY

This section covers only the color of exterior and interior materials and products that are exposed to view in the finished construction. The word "color", as used herein, includes surface color and pattern. Requirements for quality, product specifications, and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings if not identified in this specification. Items not designated for color in this section may be specified in other sections. When color is not designated for items, propose a color for approval.

PART 2 PRODUCTS

2.1 COLOR SCHEDULE

The color information provided in the following paragraphs lists the colors, patterns and textures for interior finishes, including both factory applied and field applied colors. In the case of difference between the drawings and specifications, colors identified in this specification govern.

2.2 INTERIOR FINISHES

2.2.1 Interior Floor Finishes

Provide flooring materials to match the colors listed below.

2.2.1.1 Rubber Tile

Mannington, Open Range, Color Pitman (Readniness Room)

2.2.1.2 Porcelain Tile

DalTile, Chord, Color Canon Grey CH22 Light Polished 12" x 24" (Unisex Restroom)

2.2.1.3 Grout

Bostik-Storm H198

2.2.1.4 Aluminum Transition

Manufacturers standard

2.2.1.5 Concrete

Hardened Concrete (All rooms except Readiness and Unisex RR)

2.2.2 Interior Base Finishes

Provide base materials to match the colors listed below.

2.2.2.1 Resilient Base and Moldings

Roppe, 193 Black Brown

2.2.2.2 Porcelain Tile

DalTile, Chord, Color Canon Grey CH22 Light Polished, Bullnose P43F9

2.2.2.3 Grout

Bostik-Storm H198

2.2.3 Interior Wall Finishes

Apply interior wall color to the entire wall surface, including reveals, vertical furred spaces and columns, grilles, diffusers, electrical and access panels, and piping and conduit adjacent to wall surfaces unless otherwise specified. Paint items not specified in other paragraphs to match adjacent wall surface. Provide wall materials to match the colors listed below.

2.2.3.1 Paint

Gypsum Wall Board (walls) Sherwin Williams Pediment SW7634

Metal Stairs and Railings - Flat Black

2.2.3.2 Porcelain Tile

DalTile, Chord, Color Canon Grey CH22 Light Polished 12" x 24" (Unisex Restroom)

2.2.3.3 Grout

Bostik-Storm H198

2.2.3.4 Exposed Structural Steel

See 07 81 00 SPRAY-APPLIED FIREPROOFING

2.2.4 Interior Ceiling Finishes

Apply ceiling colors to ceiling surfaces including soffits, furred down areas, grilles, diffusers, registers, and access panels. In addition, apply ceiling color to joists, underside of roof deck, and conduit and piping where joists and deck are exposed and required to be painted. Provide ceiling materials to match the colors listed below.

2.2.4.1 Acoustical Tile and Grid

Manufacturer's Standard White

2.2.4.2 Paint (Ceilings)

Manufacturer's Standard White

2.2.5 Interior Trim

Provide interior trim to match the colors listed below.

2.2.5.1 Steel Doors and Door Frames

Sherwin Williams Mega Greige SW7031

2.2.6 Interior Window Treatment

Provide window treatments to match the colors listed below.

2.2.6.1 Horizontal Blinds

Bali 1" Lightblocker, Color 121 Brushed Aluminum

2.2.7 Interior Miscellaneous

Provide miscellaneous items to match the colors listed below.

2.2.7.1 Signage Message Color

Sherwin Williams Mega Greige SW7031

2.2.7.2 Signage Background Color

Sherwin Williams Pediment SW7634

2.2.7.3 Electrical Device Cover Plates

Sherwin Williams Mega Greige SW7031

2.2.7.4 Electrical Panels

Sherwin Williams Mega Greige SW7031

PART 3 EXECUTION

Not Used

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SECTION 09 22 00

SUPPORTS FOR PLASTER AND GYPSUM BOARD
02/10, CHG 2: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 341	(2016) Seismic Provisions for Structural Steel Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A463/A463M	(2015; R 2020; E 2020) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C645	(2014; E 2015) Nonstructural Steel Framing Members
ASTM C754	(2020) Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C841	(2003; R 2013) Installation of Interior Lathing and Furring
ASTM C847	(2014a) Standard Specification for Metal Lath

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM EMLA 920	(2009) Guide Specifications for Metal Lathing and Furring

UL SOLUTIONS (UL)

UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification

identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Metal Support Systems; G, RO

Submit for the erection of metal framing, furring, and ceiling suspension systems. Indicate materials, sizes, thicknesses, and fastenings.

SD-03 Product Data

Metal Support Systems

Recycled Content for Metal Support Systems;

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the job site and store in ventilated dry locations permitting easy access for inspection and handling. If materials are stored outdoors, stack materials off the ground, supported on a level platform, and fully protected from the weather. Handle materials carefully to prevent damage. Remove damaged items and provide new items.

PART 2 PRODUCTS

2.1 MATERIALS

Provide steel materials for metal support systems with galvanized coating ASTM A653/A653M, G-60; aluminum coating ASTM A463/A463M, T1-25; or a 55-percent aluminum-zinc coating. Provide support systems and attachments per AISC 341 in seismic zones.

Provide metal support systems containing a minimum of 20 percent recycled content. Provide data identifying percentage of recycled content for metal support systems.

2.1.1 Materials for Attachment of Lath

2.1.1.1 Suspended and Furred Ceiling Systems and Wall Furring

ASTM C841, and ASTM C847.

2.1.1.2 Non-load Bearing Wall Framing

NAAMM EMLA 920.

2.1.2 Materials for Attachment of Gypsum Wallboard

2.1.2.1 Suspended and Furred Ceiling Systems

ASTM C645.

2.1.2.2 Non-load Bearing Wall Framing and Furring

ASTM C645, but not thinner than 0.0179 inch thickness, with 0.0329 inch minimum thickness supporting wall hung items such as cabinetwork,

equipment and fixtures.

2.1.2.3 Furring Structural Steel Columns

ASTM C645. Steel (furring) clips and support angles listed in UL Fire Resistance may be provided in lieu of steel studs for erection of gypsum wallboard around structural steel columns.

2.1.2.4 Z-Furring Channels with Wall Insulation

Not lighter than 26 gage galvanized steel, Z-shaped, with 1-1/4 inch and 3/4 inch flanges and depth as required by the insulation thickness provided.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Systems for Attachment of Lath

3.1.1.1 Suspended and Furred Ceiling Systems and Wall Furring

ASTM C841, except as indicated otherwise.

3.1.1.2 Non-load Bearing Wall Framing

NAAMM EMLA 920, except provide framing members 16 inches o.c. unless indicated otherwise.

3.1.2 Systems for Attachment of Gypsum Wallboard

3.1.2.1 Suspended and Furred Ceiling Systems

ASTM C754, except provide framing members 16 inches o.c. unless indicated otherwise.

3.1.2.2 Non-load Bearing Wall Framing and Furring

ASTM C754, except as indicated otherwise.

3.1.2.3 Z-Furring Channels with Wall Insulation

Install Z-furring channels vertically spaced not more than 24 inches o.c. Locate Z-furring channels at interior and exterior corners in accordance with manufacturer's printed erection instructions. Fasten furring channels to masonry walls with powder-driven fasteners or hardened concrete steel nails through narrow flange of channel. Space fasteners not more than 16 inches o.c.

3.2 ERECTION TOLERANCES

Provide framing members which will be covered by finish materials such as wallboard, plaster, or ceramic tile set in a mortar setting bed, within the following limits:

a. Layout of walls and partitions: 1/4 inch from intended position;

b. Plates and runners: 1/4 inch in 8 feet from a straight line;

c. Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and

d. Face of framing members: 1/4 inch in 8 feet from a true plane.

Provide framing members which will be covered by ceramic tile set in dry-set mortar, latex-portland cement mortar, or organic adhesive within the following limits:

a. Layout of walls and partitions: 1/4 inch from intended position;

b. Plates and runners: 1/8 inch in 8 feet from a straight line;

c. Studs: 1/8 inch in 8 feet out of plumb, not cumulative; and

d. Face of framing members: 1/8 inch in 8 feet from a true plane.

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GYPSUM BOARD

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SECTION 09 29 00

GYPSUM BOARD
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108.11	(1992; Reaffirmed 2005) Specifications for Interior Installation of Cementitious Backer Units

ASTM INTERNATIONAL (ASTM)

ASTM C475/C475M	(2017; R 2022) Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C514	(2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board
ASTM C840	(2020) Standard Specification for Application and Finishing of Gypsum Board
ASTM C954	(2022) Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
ASTM C1002	(2022) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs
ASTM C1047	(2019) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C1178/C1178M	(2013) Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel
ASTM C1396/C1396M	(2017) Standard Specification for Gypsum Board
ASTM D226/D226M	(2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

ASTM D3273	(2021) Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalg

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

GYPSUM ASSOCIATION (GA)

GA 214	(2010) Recommended Levels of Gypsum Board Finish
GA 216	(2016) Application and Finishing of Gypsum Panel Products
GA 224	(2008) Installation of Predecorated Gypsum Board
GA 253	(2012) Application of Gypsum Sheathing

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

UL SOLUTIONS (UL)

UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Cementitious Backer Units

Glass Mat Water-Resistant Gypsum Tile Backing Board

Water-Resistant Gypsum Backing Board

Glass Mat Covered or Reinforced Gypsum Sheathing

Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

Accessories

Submit for each type of gypsum board and for cementitious backer units.

Gypsum Board

Recycled Content for Gypsum Board;

Recycled Content for Paper Facing and Gypsum Cores;

VOC Content of Joint Compound;

SD-06 Test Reports

ASTM E90 Factory Test Report;

SD-07 Certificates

Asbestos Free Materials; G, RO

Certify that gypsum board types, gypsum backing board types, cementitious backer units, and joint treating materials do not contain asbestos.

Indoor Air Quality for Gypsum Board;

Indoor Air Quality for Non-aerosol Adhesives;

Indoor Air Quality for Aerosol Adhesives;

1.3 CERTIFICATIONS

1.3.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

1.3.1.1 Ceiling and Wall Systems

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.3.1.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials in the original packages, containers, or bundles with each bearing the brand name, applicable standard designation, and name of manufacturer, or supplier.

1.4.2 Storage

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board and cementitious backer units outside, store off the ground, properly supported on a level platform, and protected from direct exposure to rain, snow, sunlight, and other extreme weather conditions. Provide adequate ventilation to prevent condensation. Store per manufacturer's recommendations for allowable temperature and humidity range. Do not store panels near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives. Do not use materials that have visible moisture or biological growth.

1.4.3 Handling

Neatly stack gypsum board and cementitious backer units flat to prevent sagging or damage to the edges, ends, and surfaces.

1.5 QUALIFICATIONS

Furnish type of gypsum board work specialized by the installer with a minimum of 3 years of documented successful experience.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not expose the gypsum board to excessive sunlight prior to gypsum board application. Maintain a continuous uniform temperature of not less than 50 degrees F and not more than 80 degrees F for at least one week prior to the application of gypsum board work, while the gypsum board application is being done, and for at least one week after the gypsum board is set. Shield air supply and distribution devices to prevent any uneven flow of air across the plastered surfaces. Provide ventilation to exhaust moist air to the outside during gypsum board application, set, and until gypsum board jointing is dry. In glazed areas, keep windows open top and bottom or side to side 3 to 4 inches. Reduce openings in cold weather to prevent freezing of joint compound when applied. For enclosed areas lacking natural ventilation, provide temporary mechanical means for ventilation. In unglazed areas subjected to hot, dry winds or temperature differentials from day to night of 20 degrees F or more, screen openings with cheesecloth or similar materials. Avoid rapid drying. During periods of

low indoor humidity, provide minimum air circulation following gypsum boarding and until gypsum board jointing complete and is dry.

1.7 FIRE RESISTIVE CONSTRUCTION

Comply with specified fire-rated assemblies for design numbers indicated per UL Fire Resistance or FM APP GUIDE.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to specifications, standards and requirements specified. Provide gypsum board types, gypsum backing board types, cementitious backing units, and joint treating materials manufactured from asbestos free materials only.

2.1.1 Gypsum Board

ASTM C1396/C1396M. Gypsum board must contain a minimum of 10 percent post-consumer recycled content, or a minimum of 20 percent post-industrial recycled content. Provide data identifying percentage of recycled content for gypsum board. Paper facings must contain a minimum of 100 percent recycled paper content. Gypsum cores must contain a minimum of 95 percent post-industrial recycled gypsum content. Provide data identifying percentage of recycled content for paper facing and gypsum cores. Provide gypsum wall board and panels meeting the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for gypsum board.

2.1.1.1 Regular

48 inch wide, 1/2 or 5/8inch thick, , tapered and featured edges. as indicated.

2.1.1.2 Type X (Special Fire-Resistant)

48 inch wide, 5/8 inch thick, tapered and featured edges.

2.1.1.3 Mold Resistant / Anti-Microbial Gypsum

ASTM D3273. 48 inch wide, 5/8 inch thick, tapered and featured edges.

2.1.2 Gypsum Backing Board

ASTM C1396/C1396M, gypsum backing board must be used as a base in a multilayer system.

2.1.2.1 Regular

48 inch wide, 5/8 inch thick, square edges.

2.1.2.2 Type X (Special Fire-Resistant)

48 inch wide, 5/8 inch thick, square edges.

2.1.3 Regular Water-Resistant Gypsum Backing Board

ASTM C1396/C1396M

2.1.3.1 Regular

48 inch wide, 5/8 inch thick, tapered edges.

2.1.3.2 Type X (Special Fire-Resistant)

48 inch wide, 5/8 inch thick, tapered edges.

2.1.4 Glass Mat Water-Resistant Gypsum Tile Backing Board

ASTM C1178/C1178M

2.1.4.1 Regular

48 inch wide, 5/8 inch thick, square edges.

2.1.4.2 Type X (Special Fire-Resistant)

48 inch wide, 5/8 inch thick, square edges.

2.1.5 Cementitious Backer Units

In accordance with the Tile Council of America (TCA) Handbook.

2.1.6 Joint Treatment Materials

ASTM C475/C475M. Product must be low emitting VOC types with VOC limits not exceeding 50 g/L. Provide data identifying VOC content of joint compound. Use all purpose joint and texturing compound containing inert fillers and natural binders, including lime compound. Pre-mixed compounds must be free of antifreeze, vinyl adhesives, preservatives, biocides and other slow releasing compounds.

2.1.6.1 Embedding Compound

Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

2.1.6.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

2.1.6.3 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

2.1.6.4 Setting or Hardening Type Compound

Specifically formulated and manufactured for use with fiber glass mesh tape.

2.1.6.5 Joint Tape

Use cross-laminated, tapered edge, reinforced paper, or fiber glass mesh

tape recommended by the manufacturer.

2.1.7 Fasteners

2.1.7.1 Nails

ASTM C514.

2.1.7.2 Screws

ASTM C1002, Type "G", Type "S" or Type "W" steel drill screws for fastening gypsum board to gypsum board, wood framing members and steel framing members less than 0.033 inch thick. ASTM C954 steel drill screws for fastening gypsum board to steel framing members 0.033 to 0.112 inch thick. Provide cementitious backer unit screws with a polymer coating.

2.1.7.3 Staples

No. 16 USS gage flattened galvanized wire staples with 7/16 inch wide crown outside measurement and divergent point for base ply of two-ply gypsum board application. Use as follows:

Length of Legs	Thickness of Gypsum Board
1-1/8 inches	1/2 inch
1-1/4 inches	5/8 inch

2.1.8 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for non-aerosol adhesives applied on the interior of the building (inside of the weatherproofing system). Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building (inside of the weatherproofing system).

2.1.8.1 Adhesive for Fastening Gypsum Board to Metal Framing

Not permitted.

2.1.9 Accessories

ASTM C1047. Fabricate from corrosion protected steel or plastic designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges must be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.

2.1.10 Asphalt Impregnated Building Felt

Provide a 15 lb asphalt moisture barrier over glass mat covered or reinforced gypsum sheathing. Conforming to ASTM D226/D226M Type 1 (No. 15) for asphalt impregnated building felt.

2.1.11 Water

Provide clean, fresh, and potable water.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Framing and Furring

Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board and cementitious backer units. Verify that all blocking, headers and supports are in place to support plumbing fixtures and to receive soap dishes, grab bars, towel racks, and similar items. Do not proceed with work until framing and furring are acceptable for application of gypsum board and cementitious backer units.

3.1.2 Gypsum Board and Framing

Verify that surfaces of gypsum board and framing to be bonded with an adhesive are free of dust, dirt, grease, and any other foreign matter. Do not proceed with work until surfaces are acceptable for application of gypsum board with adhesive.

3.1.3 Concrete Walls

Verify that surfaces of concrete walls to receive gypsum board applied with adhesive are dry, free of dust, oil, form release agents, protrusions and voids, and any other foreign matter. Do not proceed with work until surfaces are acceptable for application of gypsum board with adhesive.

3.1.4 Building Construction Materials

Do not install building construction materials that show visual evidence of biological growth.

3.2 APPLICATION OF GYPSUM BOARD

Apply gypsum board to framing and furring members in accordance with ASTM C840 or GA 216 and the requirements specified. Apply gypsum board with separate panels in moderate contact; do not force in place. Stagger end joints of adjoining panels. Neatly fit abutting end and edge joints. Use gypsum board of maximum practical length; select panel sizes to minimize waste. Cut out gypsum board to make neat, close, and tight joints around openings. In vertical application of gypsum board, provide panels in lengths required to reach full height of vertical surfaces in one continuous piece. Lay out panels to minimize waste; reuse cutoffs whenever feasible. Surfaces of gypsum board and substrate members may not be bonded together with an adhesive. Treat edges of cutouts for plumbing pipes, screwheads, and joints with water-resistant compound as recommended by the gypsum board manufacturer. Provide type of gypsum board for use in each system specified herein as indicated.

3.2.1 Application of Single-Ply Gypsum Board to Wood Framing

Apply in accordance with ASTM C840, System I or GA 216.

3.2.2 Application of Two-Ply Gypsum Board to Wood Framing

Apply in accordance with ASTM C840, System II or GA 216.

3.2.3 Adhesive Nail-On Application to Wood Framing

Apply in accordance with ASTM C840, System III or GA 216. This method may be used in lieu of ASTM C840, System I at the option of the Contractor.

3.2.4 Semi-Solid Gypsum Board Partitions

Provide in accordance with ASTM C840, System IV or GA 216 .

3.2.5 Solid Gypsum Board Partitions

Provide in accordance with ASTM C840, System V or GA 216.

3.2.6 Adhesive Application to Interior Masonry or Concrete Walls

Apply in accordance with ASTM C840, System VI or GA 216.

3.2.7 Application of Gypsum Board to Steel Framing and Furring

Apply in accordance with ASTM C840, System VIII or GA 216.

3.2.8 Arches and Bending Radii

Apply gypsum board in accordance with ASTM C840, System IX or GA 216.

3.2.9 Gypsum Board for Wall Tile or Tile Base Applied with Adhesive

In dry areas (areas other than tubs, shower enclosures, saunas, steam rooms, gang shower rooms), apply glass mat water-resistant gypsum tile backing board or water-resistant gypsum backing board in accordance with ASTM C840, System X or GA 216.

3.2.10 Exterior Application

Apply exterior gypsum board (such as at soffits) in accordance with ASTM C840, System XI or GA 216.

3.2.11 Glass Mat Covered or Fiber Reinforced Gypsum Sheathing

Apply glass mat covered or fiber reinforced gypsum sheathing in accordance to gypsum association publications GA 253. Follow gypsum sheathing manufacturer's requirements of design details for joints and fasteners and be properly installed to protect the substrate from moisture intrusion. Do not leave exposed surfaces of the glass mat covered or fiber reinforced gypsum sheathing beyond the manufacturer's recommendation without a weather barrier cladding. Provide continuous asphalt impregnated building felt over sheathing surface in shingle fashion with edges and ends lapped a minimum of 6 inch. Properly flash the openings. Seal all joints, seams, and penetrations with a compatible silicone sealant.

3.2.12 Floating Interior Angles

Minimize framing by floating corners with single studs and drywall clips. Locate the attachment fasteners adjacent to ceiling and wall intersections in accordance with ASTM C840, System XII or GA 216, for single-ply and two-ply applications of gypsum board to wood framing.

3.2.13 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C840, System XIII or GA 216. Fill control joints between studs in fire-rated construction with firesafing insulation to match the fire-rating of construction.

3.2.14 Application of Foil-Backed Gypsum Board

Apply foil-backed gypsum board in accordance with ASTM C840, System XIV or GA 216.

3.2.15 Application of Predecorated Gypsum Board

Apply predecorated gypsum board in accordance with GA 224. Attach predecorated gypsum board with adhesive and fasteners as recommended by the manufacturer. Conceal fasteners in the finished work.

3.2.16 Application of Abuse Resistant Gypsum Board

Apply in accordance with applicable system of ASTM C840 as specified or GA 216. Follow manufacturers written instructions on how to cut, drill and attach board.

3.3 APPLICATION OF CEMENTITIOUS BACKER UNITS

3.3.1 Application

In wet areas (tubs, shower enclosures, saunas, steam rooms, gang shower rooms), apply cementitious backer units in accordance with ANSI A108.11. Place a 15 lb asphalt impregnated, continuous felt paper membrane behind cementitious backer units, between backer units and studs or base layer of gypsum board. Place membrane with a minimum 6 inch overlap of sheets laid shingle style.

3.3.2 Joint Treatment

ANSI A108.11.

3.4 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C840, GA 214 and GA 216. Finish plenum areas above ceilings to Level 1 in accordance with GA 214. Finish water resistant gypsum backing board, ASTM C1396/C1396M, to receive ceramic tile to Level 2 in accordance with GA 214. Finish walls and ceilings to receive a heavy-grade wall covering or heave textured finish before painting to Level 3 in accordance with GA 214. Finish walls and ceilings without critical lighting to receive flat paints, light textures, or wall coverings to Level 4 in accordance with GA 214. Unless otherwise specified, finish all gypsum board walls, partitions and ceilings to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Tool joints as smoothly

as possible to minimize sanding and dust. Do not use self-adhering fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only. Provide treatment for water-resistant gypsum board as recommended by the gypsum board manufacturer. Protect workers, building occupants, and HVAC systems from gypsum dust.

3.4.1 Uniform Surface

Wherever gypsum board is to receive eggshell, semigloss or gloss paint finish, or where severe, up or down lighting conditions occur, finish gypsum wall surface in accordance to GA 214 Level 5. In accordance with GA 214 Level 5, apply a thin skim coat of joint compound to the entire gypsum board surface, after the two-coat joint and fastener treatment is complete and dry.

3.5 SEALING

Seal openings around pipes, fixtures, and other items projecting through gypsum board and cementitious backer units as specified in Section 07 92 00 JOINT SEALANTS. Apply material with exposed surface flush with gypsum board or cementitious backer units.

3.5.1 Sealing for Glass Mat or Reinforced Gypsum Board Sheathing

Apply silicone sealant in a 3/8 inch bead to all joints and trowel flat. Apply enough of the same sealant to all fasteners penetrating through the glass mat gypsum board surface to completely cover the penetration when troweled flat. Do not place construction and materials behind sheathing until a visual inspection of sealed joints during daylight hours has been completed by Contracting Officer.

3.6 FIRE-RESISTANT ASSEMBLIES

Wherever fire-rated construction is indicated, provide materials and application methods, including types and spacing of fasteners, wall and ceiling framing in accordance with the specifications contained in UL Fire Resistance for the Design Number(s) indicated, . Joints of fire-rated gypsum board enclosures must be closed and sealed in accordance with UL test requirements or GA requirements. Seal penetrations through rated partitions and ceilings tight in accordance with tested systems.

3.7 SOUND RATED ASSEMBLIES

When sound rated assemblies are required, provide materials and application methods, including panels, insulation, types and spacing of fasteners, wall and ceiling framing in accordance with the contract document and the description of the assembly in the ASTM E90 Factory Test Report. Seal partitions continuously with acoustical foam or sealant (both sides) and finished to match wall wherever it abuts another element such as the floor, ceiling, wall, column, mullion, or another system or assembly.

3.8 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finishes. Remove predecorated gypsum board which cannot be restored to like-new condition. Provide new predecorated gypsum board.

3.9 SHAFTWALL FRAMING

Install the shaftwall system in accordance with the system manufacturer's published instructions. Coordinate bucks, anchors, blocking and other items placed in or behind shaftwall framing with electrical and mechanical work. Patch or replace fireproofing materials which are damaged or removed during shaftwall construction.

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PORCELAIN TILE
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A108/A118/A136.1	(2019) American National Standard Specifications for theInstallation of Ceramic Tile
ANSI A137.1	(2019) American National Standards Specifications for Ceramic Tile

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2023) Standard Specification for Concrete Aggregates
ASTM C144	(2018) Standard Specification for Aggregate for Masonry Mortar
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C206	(2014; R 2022) Standard Specification for Finishing Hydrated Lime
ASTM C207	(2018) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C373	(2018; R 2023)Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products
ASTM C648	(2020) Standard Test Method for Breaking Strength of Ceramic Tile
ASTM C847	(2014a) Standard Specification for Metal Lath
ASTM C1026	(2023) Standard Test Method for Measuring the Resistance of Ceramic and Glass Tile to Freeze-Thaw Cycling

ASTM C1027	(2009; R 2017) Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

TILE COUNCIL OF NORTH AMERICA (TCNA)

TCNA Hdbk	(2017) Handbook for Ceramic, Glass, and Stone Tile Installation

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Porcelain Tile; G,DO

Transition Strips

Metal StripsSetting-BedMortar, Grout, and Adhesive

Crack Isolation Membrane

SD-04 Samples

Tile; G,DO

Transition StripsMetal StripsGroutSD-07 Certificates

Water Absorption Rates

SD-10 Operation and Maintenance Data

Porcelain Tile, Data Package 1; G, RO

1.3 CERTIFICATIONS

1.3.1 Water Absorption Rates Certification

Provide certification for each tile type indicating compliance with the following water absorption (wa) rates per ANSI A137.1 criteria as tested per ASTM C373 requirements.

a. Porcelain Tile (Impervious): Provide water absorption (wa) of 0.5 percent or less.

1.4 QUALITY ASSURANCE

Provide installers having a minimum of two years of experience with a company specializing in performing the type of work described. Each type and color of tile to be provided from a single source. Each type and color of mortar, adhesive, and grout to be provided from the same source.

1.5 DELIVERY, STORAGE, AND HANDLING

Ship tiles in sealed packages and clearly marked with the grade, type of tile, producer identification, and country of origin. Deliver materials to the project site in manufacturer's original unopened containers with seals unbroken and labels and hallmarks intact. Protect materials from weather, and store them under cover in accordance with manufacturer's printed instructions. Store and handle tiles per manufacturer's instructions for gauged porcelain tile and gauged porcelain tile panels/slabs.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not perform ceramic tile work unless the substrate and ambient temperature is at least 50 degrees F and rising. Maintain temperature above 50 degrees F while the work is being performed and for at least 7 days after completion of the work. When temporary heaters are used, ventilate the area to the outside to avoid carbon dioxide damage to new tilework.

1.7 WARRANTY

Provide manufacturer's warranty to repair or replace defective tiling materials and workmanship, including tile, mortar and grout products and installation as a system, for a period of one year from date of final acceptance of the work.

1.8 EXTRA MATERIALS

Supply an extra 2 percent of each type tile used in clean and marked cartons.

PART 2 PRODUCTS

2.1 TILE

Provide tiles that comply with ANSI A137.1 and are standard grade tiles. Provide a minimum breaking strength of 125 lbs. for wall tile and 250 lbs.

for floor tile in accordance with ASTM C648. Provide exterior building tile for cold climate projects that is approved by the manufacturer for exterior use when tested in accordance with ASTM C1026. Provide floor tiles with a minimum wet dynamic coefficient of friction (DCOF) value of 0.42 when tested in accordance with ANSI A137.1 requirements. Provide glazed floor tile with a IV-Commercial classification as rated by the manufacturer when tested in accordance with ASTM C1027 for visible abrasion resistance as related to foot traffic. For materials like tile and transition strips submit samples of sufficient size to show color range, pattern, type and joints.

Submit manufacturers' descriptive product data for ceramic, quarry and glass tiling indicated. Include manufacturers' literature, finishes, profiles and thicknesses of materials.

Submit manufacturers' operations and maintenance data for ceramic, quarry and glass tiling indicated in accordance with Section 01 78 23 OPERATIONS AND MAINTENANCE DATA.

2.1.1 Porcelain Tile

Provide through body (surface color and pattern go all the way through the tile body),rectified porcelain tile and cove base and trim pieces. Provide tile with a V2 aesthetic classification. Blend tiles in factory and in a packages to have same color range and continuous blend for installation. Provide nominal tile size(s) of 12 by 24 inch and 5/16 inch thick.

2.2 SETTING-BED

Submit manufacturer's catalog data. Compose the setting-bed of the following materials:

2.2.1 Aggregate for Concrete Fill

Conform to ASTM C33/C33M for aggregate fill. Do not exceed one-half the thickness of concrete fill for maximum size of coarse aggregate.

2.2.2 Portland Cement

Conform to ASTM C150/C150M for cement, Type I, white for wall mortar and gray for other uses.

2.2.3 Sand

Conform to ASTM C144 for sand.

2.2.4 Hydrated Lime

Conform to ASTM C206 for hydrated lime, Type S or ASTM C207, Type S.

2.2.5 Metal Lath

Conform to ASTM C847 for flat expanded type metal lath, and weighing a minimum 2.5 pound/square yard.

2.3 WATER

Provide potable water.

2.4 MORTAR, GROUT, AND ADHESIVE

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide bond coat, mortar, and grout supplied from the same manufacturer.

2.4.1 Dry-Set Portland Cement Mortar

TCNA Hdbk.

2.4.2 Furan Mortar

TCNA Hdbk.

2.4.3 Latex-Portland Cement Mortar

TCNA Hdbk.

2.4.4 Ceramic Tile Grout

TCNA Hdbk; petroleum-free and plastic-free sand-portland cement grout.

2.4.5 Epoxy Resin Grout

TCNA Hdbk. Water cleanable epoxy conforming to ANSI A108/A118/A136.1; provide manufacturer proportioned and packaged kit having hardener, resin and colored filler and horizontal and vertical grade products as applicable. Provide antimicrobial additive designed for prevention of mold and mildew.

2.4.6 Sealants

Comply with applicable regulations regarding toxic and hazardous materials and as specified. Provide sealant that does not change the color or alter the appearance of the grout. Refer to Section 07 92 00 JOINT SEALANTS.

Provide sealants used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168.

2.5 MISCELLANEOUS TRIMS

2.5.1 Transition Strips

Provide clear anodized aluminum transitions between tile and resilient flooring. Provide types as recommended by flooring manufacturer for both edges and transitions of flooring materials specified. Provide transition strips that comply with 36 CFR 1191 requirements.

2.5.2 Metal Strips

Provide Cove trim shapes, height to match tile and setting thickness, designed specifically for flooring, and wall applications. Provide extruded, clear anodized aluminum cove strip where floor tile abuts wall tile for sanitary transition and elimination of cove tile base.

2.6 CRACK ISOLATION MEMBRANE

2.6.1 General

Manufacturer's standard product that complies with ANSI A108/A118/A136.1 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

2.6.2 Chlorinated-Polyethylene Crack Isolation Membrane

Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric; 0.030inch nominal thickness.

2.7 COLOR, TEXTURE, AND PATTERN

Provide color, pattern and texture as specified in Section 09 06 00 SCHEDULES FOR FINISHES.

PART 3 EXECUTION

3.1 PREPARATORY WORK AND WORKMANSHIP

Inspect surface to receive tile in conformance to the requirements of TCNA Hdbk for surface conditions for the type setting bed specified and for workmanship. Provide variations of tiled surfaces that fall within maximum values shown below:

TYPE	WALLS	FLOORS
Dry-Set Mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.
Latex-Portland Cement Mortar	1/8 inch in 8 ft.	1/8 inch in 10 ft.
Epoxy	1/8 inch in 8 ft.	1/8 inch in 10 ft.

3.2 GENERAL INSTALLATION REQUIREMENTS

Do not start tile work until roughing in for mechanical and electrical work has been completed and tested, and built-in items requiring membrane waterproofing have been installed and tested. Close space, in which tile is being set, to traffic and other work. Keep closed until tile is firmly set. Do not start floor tile installation in spaces requiring wall tile until after wall tile has been installed. Apply tile in colors and patterns indicated in the area shown on the drawings. Install tile with the respective surfaces in true even planes to the elevations and grades shown. Provide special shapes as required for sills, jambs, recesses, offsets, external corners, and other conditions to provide a complete and neatly finished installation. Solidly back tile bases and coves with mortar. Do not walk or work on newly tiled floors without using kneeling boards or equivalent protection of the tiled surface. Keep traffic off horizontal portland cement mortar installations for at least 72 hours.

Keep all traffic off epoxy installed floors for at least 40 hours after grouting, and heavy traffic off for at least 7 days, unless otherwise specifically authorized by manufacturer. Submit manufacturer's preprinted installation instructions.

Do not install building construction materials that show visual evidence of biological growth.

3.3 INSTALLATION OF WALL TILE

Install wall tile in accordance with the TCNA Hdbk, method and with grout joints as recommended by the manufacturer for the type of tile. Install porcelain wall tile vertically stacked in restroom.

3.4 INSTALLATION OF FLOOR TILE

Install floor tile in accordance with TCNA Hdbk method and with grout joints as recommended by the manufacturer for the type of tile. Intall procelain floor tile stacked in restroom.

3.4.1 Dry-Set and Latex-Portland Cement

Use dry-set or latex-portland cement mortar to install tile directly over properly cured, plane, clean concrete slabs in accordance with TCNA Hdbk method . Use latex-portland cement when installing porcelain ceramic tile.

3.4.2 Ceramic Tile Grout

Prepare and install ceramic tile grout in accordance with TCNA Hdbk method . Provide and apply manufacturer's standard product for sealing grout joints in accordance with manufacturer's recommendations.

3.4.3 Waterproof and Crack Isolation Membranes

Install as indicated in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF MISCELLANEOUS TRIMS

3.5.1 Transition Strips

Install transition strips where indicated, in a manner similar to that of the ceramic tile floor and as recommended by the manufacturer. Provide thresholds full width of the opening. Install head joints at ends not exceeding 1/4 inch in width and grouted full.

3.5.2 Metal Trims

Install trim where indicated. Embed anchoring leg in setting mortar in accordance with manufacturer's instructions. During grouting of tile joints, immediately wipe grout from finish surface.

3.6 EXPANSION JOINTS

Form and seal joints as specified in Section 07 92 00 JOINT SEALANTS.

3.6.1 Walls

Provide expansion joints at control joints in backing material. Wherever

backing material changes, install an expansion joint to separate the different materials.

3.6.2 Floors

Provide expansion joints over construction joints, control joints, and expansion joints in concrete slabs in accordance with TCNA Hdbk method EJ171 type to suit conditions. Provide expansion joints where tile abuts restraining surfaces such as perimeter walls, curbs, and columns. Extend expansion joints through setting-beds and fill.

3.7 CLEANING AND PROTECTING

Upon completion, thoroughly clean tile surfaces in accordance with manufacturer's approved cleaning instructions. Do not use acid for cleaning glazed tile. Clean floor tile with resinous grout or with factory mixed grout in accordance with printed instructions of the grout manufacturer. After the grout has set, provide a protective coat of a noncorrosive soap or other approved method of protection for tile wall surfaces. Cover tiled floor areas with building paper before foot traffic is permitted over the finished tile floors. Provide board walkways on tiled floors that are to be continuously used as passageways by workmen. Replace damaged or defective tiles.

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SECTION 09 51 00

ACOUSTICAL CEILINGS

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SECTION 09 51 00

ACOUSTICAL CEILINGS
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM C635/C635M	(2017) Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C636/C636M	(2013) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM E795	(2016) Standard Practices for Mounting Test Specimens During Sound Absorption Tests
ASTM E1264	(2019) Acoustical Ceiling Products

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Acoustical Ceiling Systems; G, DO

Recycled Content for Type III Ceiling Tiles;

Recycled Content for Suspension Systems;

SD-07 Certificates

Indoor Air Quality for Type III Ceiling Tiles;

1.3 DELIVERY, STORAGE. AND HANDLING

Deliver materials to the site in the manufacturer's original unopened containers with brand name and type clearly marked. Carefully handle and store materials in dry, watertight enclosures. Immediately before installation, store acoustical units for not less than 24 hours at the same temperature and relative humidity as the space where they will be installed in order to assure proper temperature and moisture acclimation.

1.4 ENVIRONMENTAL REQUIREMENTS

Maintain a uniform temperature of not less than 60 degrees F nor more than 85 degrees F and a relative humidity of not more than 70 percent for 24 hours before, during, and 24 hours after installation of acoustical units.

1.5 SCHEDULING

Complete and dry interior finish work such as plastering, concrete and terrazzo work before ceiling installation. Complete mechanical, electrical, and other work above the ceiling line; install and start operating heating, ventilating, and air conditioning systems in order to maintain temperature and humidity requirements.

1.6 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period. Include an agreement to repair or replace acoustical panels that fail within the warranty period in the standard performance guarantee or warranty. Failures include, but are not limited to, sagging and warping of panels; rusting and manufacturers defects of grid system.

1.7 EXTRA MATERIALS

Furnish 10 spare tiles.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide the unit size, texture, finish, and color as specified. Coordinate the entire ceiling system with other details, like the location of access panels and ceiling penetrations, for instance, shown on the drawings. The Contractor is responsible for the final assembly and performance of the specified work. Provide the location and extent of acoustical treatment as shown on the contract drawings. Submit drawings showing suspension system, method of anchoring and fastening, details, and reflected ceiling

plan.

2.2 ACOUSTICAL CEILING SYSTEMS

Acoustical units to ASTM E1264 shall be Class A and meet the following requirements:

2.2.1 Units for Exposed-Grid System

2.2.1.1 Type

III (non-asbestos mineral fiber with painted finish). Provide Type III Acoustical Ceiling Tiles containing a minimum of 30 percent recycled content. Provide data identifying percentage of recycled content for Type III ceiling tiles. Provide certification of indoor air quality for Type III Ceiling Tiles.

2.2.1.2 Flame Spread

Class A, 25 or less

2.2.1.3 Pattern

E

2.2.1.4 Minimum NRC

0.50 when tested on mounting Type E-400 of ASTM E795.

2.2.1.5 Minimum Light Reflectance Coefficient

LR-1, 0.75 or greater

2.2.1.6 Nominal Size

24 by 24 inch

2.2.1.7 Edge Detail

Tegular

2.2.1.8 Finish

Factory-applied standard finish. See SECTION 09 06 00 SCHEDULES FOR FINISHES for color.

2.2.1.9 Minimum CAC

35

2.3 SUSPENSION SYSTEM

Provide standard exposed-grid standard width flange as indicated suspension system conforming to ASTM C635/C635M for intermediate-duty systems . Provide surfaces exposed to view of aluminum or steel with a factory-applied white baked-enamel finish . Provide wall molding having a flange of not less than 15/16 inch . Provide inside and outside corner caps . Provide a suspension system with a maximum deflection of 1/360 of the span length capable of supporting the finished ceiling, light fixtures, air diffusers, and accessories, as shown. .

Provide Suspension System containing a minimum of 15 percent recycled content. Provide data identifying percentage of recycled content for suspension systems.

2.4 HANGERS

Provide hangers and attachment capable of supporting a minimum 300 pound ultimate vertical load without failure of supporting material or attachment.

2.4.1 Wires

Conform wires to ASTM A641/A641M, Class 1, 0.11 inch in diameter.

2.4.2 Straps

Provide straps of 1 by 3/16 inch galvanized steel conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

2.4.3 Rods

Provide 3/16 inch diameter threaded steel rods, zinc or cadmium coated.

2.4.4 Masonry Anchorage Devices

Comply with ASTM C636/C636M for anchorage devices for machine screws .

2.5 ACCESS PANELS

Provide access panels that match adjacent acoustical units, designed and equipped with suitable framing and fastenings for removal and replacement without damage. Size panel to be not less than 12 by 12 inch or more than 12 by 24 inch.

a. Attach an identification plate of 0.032 inch thick aluminum, 3/4 inch in diameter, stamped with the letters "AP" and finished the same as the unit, near one corner on the face of each access panel.

b. Identify ceiling access panel by a number utilizing white identification plates or plastic buttons with contrasting numerals. Provide plates or buttons of minimum 1 inch diameter and securely attached to one corner of each access unit. Provide a typewritten card framed under glass listing the code identification numbers and corresponding system descriptions listed above. Mount the framed card where directed and furnish a duplicate card to the Contracting Officer. Code identification system is as follows:

(1) Fire detection/alarm system

(2) Air conditioning controls

(3) Plumbing system

(4) Heating systems

(5) Air conditioning duct system

(6) Sprinkler system

(7) Intercommunication system

2.6 FINISHES

Use manufacturer's standard textures, patterns and finishes as specified for acoustical units and suspension system members. Treat ceiling suspension system components to inhibit corrosion.

2.7 COLORS AND PATTERNS

Use colors and patterns for acoustical units and suspension system components as specified in Section 09 06 00 SCHEDULES FOR FINISHES.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Examine surfaces to receive directly attached acoustical units for unevenness, irregularities, and dampness that would affect quality and execution of the work. Rid areas, where acoustical units will be cemented, of oils, form residue, or other materials that reduce bonding capabilities of the adhesive. Complete and dry interior finish work such as plastering, concrete, and tile work before installation. Complete and approve mechanical, electrical, and other work above the ceiling line prior to the start of acoustical ceiling installation. Provide acoustical work complete with necessary fastenings, clips, and other accessories required for a complete installation. Do not expose mechanical fastenings in the finished work. Lay out hangers for each individual room or space. Provide hangers to support framing around beams, ducts, columns, grilles, and other penetrations through ceilings. Keep main runners and carrying channels clear of abutting walls and partitions. Provide at least two main runners for each ceiling span. Wherever required to bypass an object with the hanger wires, install a subsuspension system so that all hanger wires will be plumb.

3.1.1 Suspension System

Install suspension system in accordance with ASTM C636/C636M and as specified herein. Do not suspend hanger wires or other loads from underside of steel decking.

3.1.1.1 Plumb Hangers

Install hangers plumb and not pressing against insulation covering ducts and pipes. Where lighting fixtures are supported from the suspended ceiling system, provide hangers at a minimum of four hangers per fixture and located not more than 6 inch from each corner of each fixture.

3.1.1.2 Splayed Hangers

Splay (slope or slant) hangers around obstructions, offsetting the resulting horizontal force by bracing, countersplaying, or other acceptable means.

3.1.2 Wall Molding

Provide wall molding where ceilings abut vertical surfaces. Miter corners where wall moldings intersect or install corner caps. Secure wall molding not more than 3 inch from ends of each length and not more than 16 inch on centers between end fastenings. Provide wall molding springs at each acoustical unit in semi-exposed or concealed systems.

3.2 CEILING ACCESS PANELS

Locate ceiling access panels directly under the items which require access.

3.3 CLEANING

Following installation, clean dirty or discolored surfaces of acoustical units and leave them free from defects. Remove units that are damaged or improperly installed and provide new units as directed.

-- End of Section --

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SECTION 09 65 00

RESILIENT FLOORING
08/10, CHG 3: 08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4078	(2002; R 2015) Water Emulsion Floor Polish
ASTM E648	(2023) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F710	(2022) Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
ASTM F1344	(2021a) Standard Specification for Rubber Floor Tile
ASTM F1482	(2021) Standard Practice for Installation and Preparation of Panel Type Underlayments to Receive Resilient Flooring
ASTM F1861	(2021) Standard Specification for Resilient Wall Base
ASTM F1869	(2023) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F2170	(2019a) Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop DrawingsResilient Flooring and AccessoriesSD-03 Product Data

Resilient Flooring and Accessories; G, DO

Adhesives

SD-04 Samples

Resilient Flooring and Accessories; G, DO

SD-06 Test Reports

Moisture, Alkalinity and Bond Tests; G, RO

SD-08 Manufacturer's Instructions

Surface Preparation

Installation

SD-10 Operation and Maintenance Data

Resilient Flooring and Accessories; G, RO

1.3 CERTIFICATES

1.3.1 Indoor Air Quality

Submit required indoor air quality certifications and validations in one submittal package.

1.3.1.1 Floor Covering Materials

Provide current product certification documentation from certification body.

1.3.1.2 Adhesives, Caulking and Sealants

Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the building site in original unopened containers bearing the manufacturer's name, style name, pattern color name and number, production run, project identification, and handling instructions. Store materials in a clean, dry, secure, and well-ventilated area with ambient air temperature maintained above 68 degrees F and below 85 degrees F, stacked according to manufacturer's

recommendations. Protect materials from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances. Observe ventilation and safety procedures specified in the MSDS.

1.5 ENVIRONMENTAL REQUIREMENTS

Maintain areas to receive resilient flooring at a temperature above 68 degrees F and below 85 degrees F for 3 days before application, during application and 2 days after application, unless otherwise directed by the flooring manufacturer for the flooring being installed. Maintain a minimum temperature of 55 degrees F thereafter. Provide adequate ventilation to remove moisture from area and to comply with regulations limiting concentrations of hazardous vapors.

1.6 SCHEDULING

Schedule resilient flooring application after the completion of other work which would damage the finished surface of the flooring.

1.7 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

1.8 EXTRA MATERIALS

Provide extra flooring material of each color and pattern at the rate of 5 tiles total. Provide extra wall base material composed of 20 linear feet of each type, color and pattern. Package all extra materials in original properly marked containers bearing the manufacturer's name, brand name, pattern color name and number, production run, and handling instructions. Provide extra materials from the same lot as those installed. Leave extra stock at the site in location assigned by Contracting Officer.

PART 2 PRODUCTS

2.1 RUBBER TILE

Conform to ASTM F1344 Class 1 homogeneous, Size of plank (6 x 42) inch. Provide 0.125 inch overall thickness.

2.2 WALL BASE

Conform to ASTM F1861, Type TS (vulcanized thermoset rubber) Style B (coved - installed with resilient flooring). Provide 4 inch high and a minimum 1/8 inch thick wall base. Provide job formed corners in matching height, shape, and color.

2.3 MOULDING

Provide tapered mouldings of vinyl, rubber, or clear anodized aluminum and types as recommended by flooring manufacturer for both edges and transitions of flooring materials specified. Provide vertical lip on moulding of maximum 1/4 inch. Provide bevel change in level between 1/4 and 1/2 inch with a slope no greater than 1:2.

2.4 ADHESIVES

Provide adhesives for flooring, base and accessories as recommended by the

manufacturer and comply with local indoor air quality standards. Submit manufacturer's descriptive data, documentation stating physical characteristics, and mildew and germicidal characteristics.

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of GS-36.

2.5 SURFACE PREPARATION MATERIALS

Provide surface preparation materials, such as panel type underlayment, lining felt, and floor crack fillers as recommended by the flooring manufacturer for the subfloor conditions. Comply with ASTM F1482 for panel type underlayment products.

2.6 POLISH/FINISH

Provide polish finish as recommended by the manufacturer and conform to ASTM D4078 for polish.

2.7 CAULKING AND SEALANTS

Provide caulking and sealants in accordance with Section 07 92 00 JOINT SEALANTS.

2.8 MANUFACTURER'S COLOR, PATTERN AND TEXTURE

Provide color, pattern and texture for resilient flooring and accessories in accordance with Section 09 06 00 SCHEDULES FOR FINISHES Color listed is not intended to limit the selection of equal colors from other manufacturers. Provide flooring in any one continuous area or replacement of damaged flooring in continuous area from same production run with same shade and pattern. Submit scaled drawings indicating patterns (including location of patterns and colors) and dimensions. Submit manufacturer's descriptive data and three samples of each indicated color and type of flooring, base, mouldings, and accessories sized a minimum 2-1/2 by 4 inch. Submit Data Package 1 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

2.9 FIRE RESISTANCE TESTING REQUIREMENTS

Provide a minimum average critical radiant flux of 0.22 watts per square centimeter for flooring in corridors and exits when tested in accordance with ASTM E648.

PART 3 EXECUTION

3.1 EXAMINATION

Examine and verify that site conditions are in agreement with the design package. Report all conditions that will prevent a proper installation. Do not take any corrective action without written permission from the Government. Work will proceed only when conditions have been corrected and accepted by the installer. Submit manufacturer's printed installation

instructions for all flooring materials and accessories, including preparation of substrate, seaming techniques, and recommended adhesives.

3.2 SURFACE PREPARATION

Provide a smooth, true, level plane for surface preparation of the flooring, except where indicated as sloped. Floor to be flat to within 3/16 inch in 10 feet. Prepare subfloor in accordance with flooring manufacturer's recommended instructions. Prepare the surfaces of lightweight concrete slabs (as defined by the flooring manufacturer) as recommended by the flooring manufacturer. Comply with ASTM F710 for concrete subfloor preparation. Floor fills or toppings may be required as recommended by the flooring manufacturer. Install underlayments, when required by the flooring manufacturer, in accordance with manufacturer's recommended printed installation instructions. Comply with ASTM F1482 for panel type underlayments. Before any work under this section is begun, correct all defects such as rough or scaling concrete, chalk and dust, cracks, low spots, high spots, and uneven surfaces. Repair all damaged portions of concrete slabs as recommended by the flooring manufacturer. Remove concrete curing and sealer compounds from the slabs, other than the type that does not adversely affect adhesion. Remove paint, varnish, oils, release agents, sealers, waxes, and adhesives, as required by the flooring product in accordance with manufacturer's printed installation instructions.

3.3 MOISTURE, ALKALINITY AND BOND TESTS

Determine the suitability of the concrete subfloor for receiving the resilient flooring with regard to moisture content and pH level by moisture and alkalinity tests. Conduct moisture testing in accordance with ASTM F1869 or ASTM F2170, unless otherwise recommended by the flooring manufacturer. Conduct alkalinity testing as recommended by the flooring manufacturer. Determine the compatibility of the resilient flooring adhesives to the concrete floors by a bond test in accordance with the flooring manufacturer's recommendations. Submit copy of test reports for moisture and alkalinity content of concrete slab, and bond test stating date of test, person conducting the test, and the area tested.

3.4 GENERAL INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

3.5 PLACING RUBBER TILE

Install rubber tile and accessories in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Provide square, symmetrical, tight, and even flooring lines and joints. Keep each floor in true, level plane, except where slope is indicated. Vary width of edge tiles as necessary to maintain full-size tiles, except where irregular-shaped rooms makes it impossible. Cut flooring to fit around all permanent fixtures, built-in furniture and cabinets, pipes, and outlets. Cut, fit, and scribe flooring to walls and partitions after field flooring has been applied.

3.6 PLACING MOULDING

Provide moulding where flooring termination is higher than the adjacent

finished flooring and at transitions between different flooring materials. When required, locate moulding under door centerline. Moulding is not required at doorways where thresholds are provided. Secure moulding with adhesive as recommended by the manufacturer. Prepare and apply adhesives in accordance with manufacturer's printed directions.

3.7 PLACING WALL BASE

Install wall base in accordance with manufacturer's printed installation instructions. Prepare and apply adhesives in accordance with manufacturer's printed directions. Tighten base joints and make even with adjacent resilient flooring. Fill voids along the top edge of base at masonry walls with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners.

3.8 CLEANING

Immediately upon completion of installation of flooring in a room or an area, dry and clean the flooring and adjacent surfaces to remove all surplus adhesive. Clean flooring as recommended in accordance with manufacturer's printed maintenance instructions and within the recommended time frame. As required by the manufacturer, apply the recommended number of coats and type of polish and finish in accordance with manufacturer's written instructions.

3.9 PROTECTION

From the time of installation until acceptance, protect flooring from damage as recommended by the flooring manufacturer. Remove and replace flooring which becomes damaged, loose, broken, or curled and wall base which is not tight to wall or securely adhered.

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SECTION 09 90 00

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02/21

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SECTION 09 90 00

PAINTS AND COATINGS
02/21

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.

b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.

c. Existing coated surfaces that are damaged during performance of the work.

1.1.1.1 Exterior Painting

Includes new surfaces of the buildings and appurtenances. Also included are existing coated surfaces made bare by cleaning operations.

1.1.1.2 Interior Painting

Includes new surfaces of the building- and appurtenances as indicated and existing coated surfaces made bare by cleaning operations. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

a. Exposed columns, girders, beams, joists, and metal deck; For exposed steel structural members that are to be fire-rated, see 07 81 00 SPRAY-APPLIED FIREPROOFING.

b. Other contiguous surfaces.

1.1.2 Painting Excluded

Do not paint the following unless indicated otherwise

a. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place

b. Surfaces in concealed spaces. Concealed spaces are defined as enclosed spaces above suspended ceilings, furred spaces, attic spaces, crawl spaces, elevator shafts and chases

c. Steel to be embedded in concrete

d. Copper, stainless steel, aluminum, anodized aluminum, brass, and lead except existing coated surfaces

e. Hardware, fittings, and other factory finished items

f. Ductwork

g. Exposed conduit

h. Factory finished window frames

1.1.3 Exterior Painting of Site Work Items

Field coat the following items:

	New Surfaces	
a.Bollards		

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH 0100 (2017; Suppl 2020) Documentation of the Threshold Limit Values and Biological Exposure Indices

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1 (2020) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM D523 (2014; R 2018) Standard Test Method for Specular Gloss

ASTM D6386 (2016a) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

Intelligence Bulletin 65 (2013) Occupational Exposure to Carbon Nanotubes and Nanofibers

MASTER PAINTERS INSTITUTE (MPI)

MPI 2 (2012) Aluminum Heat Resistant Enamel (up to 427 C and 800 F

MPI 8 (2016) Alkyd, Exterior Flat (MPI Gloss Level I)

MPI 9 (2016) Alkyd, Exterior Gloss (MPI Gloss Level 6)

MPI 11	(2016) Latex, Exterior Semi-Gloss, MPI Gloss Level 5
MPI 19	(2012) Primer, Zinc Rich, Inorganic
MPI 21	(2012) Heat Resistant Coating, (Up to 205°C/402°F), MPI Gloss Level 6
MPI 23	(2015) Primer, Metal, Surface Tolerant
MPI 47	(2016) Alkyd, Interior, Semi-Gloss (MPI Gloss Level 5)
MPI 50	(2015) Primer Sealer, Latex, Interior
MPI 72	(2016) Polyurethane, Two-Component, Pigmented, Gloss (MPI Gloss Level 6-7)
MPI 77	(2015) Epoxy, Gloss
MPI 79	(2016) Primer, Alkyd, Anti-Corrosive for Metal
MPI 94	(2016) Alkyd, Exterior, Semi-Gloss (MPI Gloss Level 5)
MPI 95	(2015) Primer, Quick Dry, for Aluminum
MPI 101	(2016) Primer, Epoxy, Anti-Corrosive, for Metal
MPI 107	(2016) Primer, Rust-Inhibitive, Water Based
MPI 108	(2015) Epoxy, High Build, Low Gloss
MPI 119	(2016) Latex, Exterior, Gloss (MPI Gloss Level 6)
MPI 134	(2015) Primer, Galvanized, Water Based
MPI 145	(2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 3)
MPI 146	(2016) Latex, Interior, Institutional Low Odor/VOC, (MPI Gloss Level 4)
MPI 147	(May 2016) Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (MPI Gloss Level 5)
MPI 149	(2016) Primer Sealer, Interior, Institutional Low Odor/VOC
MPI 153	(2016) Light Industrial Coating, Interior, Water Based, Semi-Gloss (MPI Gloss Level 5)
MPI 161	(2016) Light Industrial Coating, Exterior, Water Based (MPI Gloss Level 3)

MPI 163	(2016) Light Industrial Coating, Exterior, Water Based, Semi-Gloss (MPI Gloss Level 5)
MPI 164	(2016) Light Industrial Coating, Exterior, Water Based, Gloss (MPI Gloss Level 6)
MPI ASM	(2019) Architectural Painting Specification Manual
MPI GPS-1-14	(2014) Green Performance Standard GPS-1-14
MPI GPS-2-14	(2014) Green Performance Standard GPS-2-14
MPI MRM	(2015) Maintenance Repainting Manual

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Glossary	(2011) SSPC Protective Coatings Glossary
SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 2	(2018) Hand Tool Cleaning
SSPC SP 3	(2018) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning
SSPC VIS 3	(2004) Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-313	(2018) Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1000	Air Contaminants

1.3 DEFINITIONS

1.3.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to

qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third-party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

1.3.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing must be accomplished by an MPI testing lab.

1.3.3 Coating

SSPC Glossary; (1) A liquid, liquefiable, or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer; (2) Generic term for paint, lacquer, enamel.

1.3.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

1.3.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five levels are generically defined under the Assessment sections in the MPI MRM, MPI Maintenance Repainting Manual.

1.3.6 EXT

MPI short term designation for an exterior coating system.

1.3.7 INT

MPI short term designation for an interior coating system.

1.3.8 Loose Paint

Paint or coating that can be removed with a dull putty knife.

1.3.9 mil / mils

The English measurement for 0.001 in or one one-thousandth of an inch.

1.3.10 MPI Gloss Levels

MPI system of defining gloss. Seven gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

Gloss Level	Description	Units at 60 degree angle	Units at 80 degree angle
G1	Matte or Flat	0 to 5	10 max

Gloss Level	Description	Units at 60 degree angle	Units at 80 degree angle
G2	Velvet	0 to 10	10 to 35
G3	Eggshell	10 to 25	10 to 35
G4	Satin	20 to 35	35 min
G5	Semi-Gloss	35 to 70	
G6	Gloss	70 to 85	
G7	High Gloss		

Gloss is tested in accordance with ASTM D523. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

1.3.11 MPI System Number

The MPI coating system number in each MPI Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN).

1.3.12 Paint

SSPC Glossary; (1) Any pigmented liquid, liquefiable, or mastic composition designed for application to a substrate in a thin layer that is converted to an opaque solid film after application. Used for protection, decoration, identification, or to serve some other functional purposes; (2) Application of a coating material.

1.3.13 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

1.3.14 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Samples of specified materials may be taken and tested for compliance with specification requirements.

SD-02 Shop Drawings

Piping Identification

SD-03 Product Data

Coating; G, DO

Product Data Sheets

SD-04 Samples

Color; G, DO

SD-07 Certificates

Indoor Air Quality for Paints and Primers

SD-08 Manufacturer's Instructions

Application Instructions

Mixing

Manufacturer's Safety Data Sheets

1.5 QUALITY ASSURANCE

1.5.1 Regulatory Requirements

1.5.1.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify Contracting Officer of any paint specified herein which fails to conform.

1.5.1.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.5.1.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.5.1.4 Asbestos Content

Provide asbestos-free materials.

1.5.1.5 Mercury Content

Provide materials free of mercury or mercury compounds.

1.5.1.6 Silica

Provide abrasive blast media containing no free crystalline silica.

1.5.1.7 Human Carcinogens

Provide materials that do not contain ACGIH 0100 confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.5.1.8 Carbon Based Fibers / Tubes

Materials must not contain carbon based fibers such as carbon nanotubes or carbon nanofibers. Intelligence Bulletin 65 ranks toxicity of carbon nanotubes on a par with asbestos.

1.5.2 Approved Products List

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of Contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire Contract and each coating system is to be from a single manufacturer. Provide all coats on a particular substrate from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

1.5.3 Paints and Coatings Indoor Air Quality Certifications

Provide paint and coating products certified to meet indoor air quality requirements by MPI GPS-1-14, MPI GPS-2-14 or provide certification by other third-party programs. Provide current product certification documentation from certification body.

Provide certification of Indoor Air Quality for Paints and Primers. Submit required indoor air quality certifications in one submittal package.

1.6 PACKAGING, LABELING, AND STORAGE

Provide paints in sealed containers that legibly show the Contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Furnish pigmented paints in containers not larger than 5 gallons. Store paints and thinners in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F.

1.7 SAFETY AND HEALTH

Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS and in Appendix A of EM 385-1-1. Include in the Activity Hazard Analysis the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.7.1 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

a. The applicable manufacturer's Safety Data Sheets (SDS) or local regulation.

b. 29 CFR 1910.1000.

c. ACGIH 0100, threshold limit values.

Submit manufacturer's Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

1.8 ENVIRONMENTAL REQUIREMENTS

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation.

1.8.1 Coatings

Do not apply coating when air or substrate conditions are:

a. Less than 5 degrees F above dew point;

b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Do not, under any circumstances, violate the manufacturer's application recommendations.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit Product Data Sheets for specified coatings and solvents. All interior use paints shall be low-VOC paint. Provide preprinted cleaning and maintenance instructions for all coating systems. Submit Manufacturer's Instructions on Mixing and Application Instructions: Detailed mixing and application instructions, minimum and maximum application temperature and humidity, pot life, and curing and drying times between coats.

2.2 COLOR SELECTION OF FINISH COATS

Provide colors of finish coats as indicated or specified. Allow Contracting Officer to select colors not indicated or specified. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for use only if they conform to specified requirements. Products of other manufacturers are acceptable if the colors are approximately the colors indicated and the product conforms to specified requirements.

Provide color, texture, and pattern of wall coating systems in accordance with Section 09 06 00 SCHEDULES FOR FINISHES. Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated. Submit color stencil codes. Tint each coat progressively darker to enable confirmation of the number of coats.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to

be coated. Following completion of painting, reinstall removed items by workmen skilled in the trades. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

3.2 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Schedule cleaning so that dust and other contaminants will not fall on wet, newly painted surfaces. Spot-prime exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas. Refer to MPI ASM and MPI MRM for additional more specific substrate preparation requirements.

3.3 PREPARATION OF METAL SURFACES

3.3.1 New Ferrous Surfaces

a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: Solvent clean or detergent wash in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to SSPC SP 2, SSPC SP 3, SSPC SP 6/NACE No.3, or SSPC SP 10/NACE No. 2. Protect shop-coated ferrous surfaces from corrosion by treating and touching up corroded areas immediately upon detection.

b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances will be removed and replaced.

3.3.2 Final Ferrous Surface Condition:

3.3.2.1 Tool Cleaned Surfaces

Comply with SSPC SP 2 and SSPC SP 3. Use as a visual reference, photographs in SSPC VIS 3 for the appearance of cleaned surfaces.

3.3.3 Galvanized Surfaces

a. New Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with solvent, or non-alkaline detergent solution in accordance with SSPC SP 1. Completely remove coating by brush-off abrasive blast if the galvanized metal has been passivated or stabilized. Do not "passivate" or "stabilize" new galvanized steel to be coated. If the absence of hexavalent stain inhibitors is not documented, test as described in ASTM D6386, Appendix X2, and remove by one of the methods described therein.

Galvanized With Severe Deteriorated Coating or Severe Rusting: Shall be removed and replaced.

3.3.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

3.3.5 Existing Surfaces with a Bituminous or Mastic-Type Coating

Remove chalk, mildew, and other loose material by washing with a solution of 1/2 cup trisodium phosphate, 1/4 cup household detergent, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water.

3.4 APPLICATION

3.4.1 Coating Application

a. Comply with applicable federal, state and local laws enacted to ensure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

b. At the time of application, paint must show no signs of deterioration. Maintain uniform suspension of pigments during application.

c. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Use rollers for applying paints and enamels of a type designed for the coating to be applied and the surface to be coated. Wear protective clothing and respirators when applying oil-based paints or using spray equipment with any paints.

d. Only apply paints, except water-thinned types, to surfaces that are completely free of moisture as determined by sight or touch.

e. Thoroughly work coating materials into joints, crevices, and open spaces. Pay special attention to ensure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

f. Apply each coat of paint so that dry film is of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Completely hide all blemishes.

g. Touch up damaged coatings before applying subsequent coats. Broom clean and clear dust from interior areas before and during the application of coating material.

h. Apply paint to new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metal work, and accessories. Shield sprinkler heads with protective coverings while painting is in progress. Remove sprinkler heads which have been painted and replace with new sprinkler heads. Unfinished spaces include attic spaces, spaces above suspended ceilings, crawl spaces, pipe chases, mechanical equipment room, and space where walls or ceiling are not painted or not constructed of a prefinished material. Upon completion of painting, remove protective covering from sprinkler heads.

i. Sprinkler Piping: Provide primed surfaces with two coats of paint to

match adjacent surfaces, except provide valves and operating accessories with one coat of red alkyd gloss enamel (MPI 9) applied to a minimum dry film thickness of 1.0 mil or two component gloss polyurethane (MPI 72) in exterior applications.

j. Provide labeling on the surfaces of all feed and cross mains to show the pipe function such as "Sprinkler System", "Fire Department Connection", "Standpipe". For pipe sizes 4-inch and larger provide white painted stenciled letters and arrows, a minimum of 2 in in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 4-inch, provide white painted stenciled letters and arrows, a minimum of 0.75 in in height and visible from the floor.

k. All fire suppression system valves must be marked with permanent tags indicating normally open or normally closed.

l. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.

m. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Cover each preceding coat or surface completely by ensuring visually perceptible difference in shades of successive coats.

n. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

o. Thermosetting Paints: Apply topcoats over thermosetting paints (epoxies and urethanes) within the overcoat window recommended by the manufacturer.

3.4.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. Verify that the written permission includes quantities and types of thinners to use.

When thinning is allowed, thin paints immediately prior to application with not more than one pint of suitable thinner per gallon. The use of thinner does not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning cannot cause the paint to exceed limits on volatile organic compounds. Do not mix paints of different manufacturers.

3.4.3 Two-Component Systems

Mix two-component systems in accordance with manufacturer's instructions. Follow recommendation by the manufacturer for any thinning of the first coat to ensure proper penetration and sealing for each type of substrate.

3.4.4 Coating Systems

a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

Table for Exterior Applications	
MPI Division	Substrate Application
MPI Division 3	Exterior Concrete Paint Table
MPI Division 4	Exterior Concrete Masonry Units Paint Table
MPI Division 5	Exterior Metal, Ferrous and Non-Ferrous Paint Table
MPI Division 6	Exterior Wood; Dressed Lumber, Paneling, Decking, Shingles Paint Table
MPI Division 9	Exterior Stucco Paint Table
MPI Division 10	Exterior Cloth Coverings and Bituminous Coated Surfaces Paint Table

Table for Interior Applications	
MPI Division	Substrate Application
MPI Division 3	Interior Concrete Paint Table
MPI Division 4	Interior Concrete Masonry Units Paint Table
MPI Division 5	Interior Metal, Ferrous and Non-Ferrous Paint Table
MPI Division 6	Interior Wood Paint Table
MPI Division 9	Interior Plaster, Gypsum Board, Textured Surfaces Paint Table

b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness, where specified, refers to the minimum dry film thickness.

c. Coatings for Surfaces Not Specified Otherwise: Coat unspecified surfaces the same as surfaces having similar conditions of exposure.

d. Existing Surfaces Damaged During Performance of the Work, Including New Patches In Existing Surfaces: Coat surfaces with the following:

(1) One coat of primer.

(2) One coat of undercoat or intermediate coat.

(3) One topcoat to match adjacent surfaces.

e. Existing Coated Surfaces To Be Painted: Apply coatings conforming to the respective specifications listed in the Tables herein, except that pretreatments, sealers and fillers need not be provided on surfaces where existing coatings are soundly adhered and in good condition. Do not omit undercoats or primers.

3.5 COATING SYSTEMS FOR METAL

Apply coatings of Tables in MPI Division 5 for Exterior and Interior.

a. Apply specified ferrous metal primer to steel surfaces on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.

b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.

c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.

d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.

e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat. Overcoat these items with the specified ferrous-metal primer prior to application of finish coats.

f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

3.6 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in MPI Division 3, 4 and 9 for Exterior and Interior.

3.7 PIPING IDENTIFICATION

Piping Identification, Including Surfaces In Concealed Spaces: Provide in accordance with ASME A13.1. Place stenciling in clearly visible locations. On piping not covered by ASME A13.1, stencil approved names or code letters, in letters a minimum of 1/2 inch high for piping and a minimum of 2 inches high elsewhere. Stencil arrow-shaped markings on piping to indicate direction of flow using black stencil paint.

3.8 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

3.9 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows. Do not use kerosene or any such organic solvents to clean up water based paints. Properly dispose of paints or solvents in designated containers. Close and seal partially used containers of paint to maintain quality as necessary for reuse. Store in protected, well-ventilated, fire-safe area at moderate temperature. Place materials defined as hazardous or toxic waste in designated containers. Set aside extra paint for future color matches or reuse by the Government. Where local options exist for leftover paint recycling, collect all waste paint by type and provide for delivery to recycling or collection facility for reuse by local organizations.

3.10 PAINT TABLES

All DFT's are minimum values. Acceptable products are listed in the MPI Green Approved Products List, available at http://www.specifygreen.com/APL/ProductIdxByMPInum.asp.

3.10.1 Exterior Paint Tables

3.10.1.1 MPI Division 3: Exterior Concrete Paint Table

A. Concrete

Not painted.

3.10.1.2 MPI Division 5: Exterior Metal, Ferrous and Non-Ferrous Paint Table

A. Steel / Ferrous Surfaces

(1) New Steel that has been hand or power tool cleaned to SSPC SP 2 or SSPC SP 3

Alkyd					
New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1Q-G5 (Semigloss	MPI REX 5.1D-G5 (Semigloss)	MPI 23	MPI 94	MPI 94	5.25 mils
MPI EXT 5.1Q-G6 (Gloss)	MPI REX 5.1D-G6 (Gloss)	MPI 23	MPI 9	MPI 9	5.25 mils
Topcoat: Coating to match adjacent surfaces.					

(2) New Steel that has been blast-cleaned to SSPC SP 6/NACE No.3

Alkyd

New	Existing, uncoated	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1D-G5 (Semigloss)	MPI REX 5.1D-G5 (Semigloss)	MPI 79	MPI 94	MPI 94	5.25 mils
MPI EXT 5.1D-G6 (Gloss)	MPI REX 5.1D-G6 (Gloss)	MPI 79	MPI 9	MPI 9	5.25 mils
Topcoat: Coating to match adjacent surfaces.					

(3) New steel blast cleaned to SSPC SP 10/NACE No. 2

Waterborne Light Industrial					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1R-G5 (Semigloss)	MPI EXT 5.1R-G5 (Semigloss)	MPI 101	MPI 108	MPI 163	8.5 mils
MPI EXT 5.1R-G6 (Gloss)	MPI EXT 5.1R-G6 (Gloss)	MPI 101	MPI 108	MPI 164	8.5 mils
Topcoat: Coating to match adjacent surfaces.					

Pigmented Polyurethane					
New	Existing	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.1J-G6 (Gloss)	MPI EXT 5.1J-G6 (Gloss)	MPI 101	MPI 108	MPI 72	8.5 mils
Topcoat: Coating to match adjacent surfaces.					

B. Exterior Galvanized Surfaces

(1) New Galvanized surfaces

Waterborne Primer / Latex				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT

EXT 5.3H-G5 (Semigloss)	MPI 134	MPI 11	MPI 11	4.5 mils
MPI EXT 5.3H-G6 (Gloss)	MPI 134	MPI 119	MPI 119	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Waterborne Primer / Waterborne Light Industrial Coating				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.3J-G5 (Semigloss)	MPI 134	MPI 163	MPI 163	4.5 mils
MPI EXT 5.3J-G6 (Gloss)	MPI 134	MPI 164	MPI 164	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Epoxy Primer / Waterborne Light Industrial Coating				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.3K-G5 (Semigloss)	MPI 101	MPI 163	MPI 163	5 mils
MPI EXT 5.3K-G6 (Gloss)	MPI 101	MPI 164	MPI 164	5 mils
Topcoat: Coating to match adjacent surfaces.				

Pigmented Polyurethane				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.3L-G6 (Gloss)	MPI 101	N/A	MPI 72	5 mils
Topcoat: Coating to match adjacent surfaces.				

(2) Galvanized surfaces with slight coating deterioration; little or no rusting

Waterborne Light Industrial Coating

Galvanized Surfaces with slight coating deterioration	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3J-G5 (Semigloss)	MPI 134	N/A	MPI 163	4.5 mils
Topcoat: Coating to match adjacent surfaces.				

Pigmented Polyurethane				
Galvanized Surfaces with slight coating deterioration	Primer	Intermediate	Topcoat	System DFT
MPI REX 5.3D-G6 (Gloss)	MPI 101	N/A	MPI 72	5 mils
Topcoat: Coating to match adjacent surfaces.				

C. Exterior Surfaces, Other Metals (Non-Ferrous)

(1) Aluminum, aluminum alloy and other miscellaneous non-ferrous metal items not otherwise specified except hot metal surfaces, roof surfaces, and new prefinished equipment

Alkyd				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT
MPI EXT 5.4F-G1 (Flat	MPI 95	MPI 8	MPI 8	5 mils
MPI EXT 5.4F-G5 (Semigloss)	MPI 95	MPI 94	MPI 94	5 mils
MPI EXT 5.4F-G6 (Gloss)	MPI 95	MPI 9	MPI 9	5 mils
Topcoat: Coating to match adjacent surfaces.				

Waterborne Light Industrial Coating				
New Galvanized Surfaces	Primer	Intermediate	Topcoat	System DFT

MPI EXT 5.4F-G1 (Flat	MPI 95	MPI 161	MPI 161	5 mils
MPI EXT 5.4F-G5 (Semigloss)	MPI 95	MPI 163	MPI 163	5 mils
MPI EXT 5.4F-G6 (Gloss)	MPI 95	MPI 164	MPI 164	5 mils
Topcoat: Coating to match adjacent surfaces.				

D. Exterior Hot Surfaces

(1) Hot metal surfaces, excluding stainless steel smokestacks, subject to temperatures up to 400 degrees F

Heat Resistant Enamel				
New	N/A	Intermediate	Topcoat	System DFT
MPI EXT 5.2A	MPI 21	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

(2) Ferrous metal subject to high temperature, up to 750 degrees F

Inorganic Zinc Rich Coating				
New	N/A	Intermediate	Topcoat	System DFT
MPI EXT 5.2C	MPI 19	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

Heat Resistant Aluminum Enamel				
New	N/A	Intermediate	Topcoat	System DFT
MPI EXT 5.2B	MPI 2	N/A	N/A	Per Manufacturer
Surface preparation and number of coats per manufacturer's instructions.				

3.10.2 Interior Paint Tables
3.10.2.1 MPI Division 9: Interior Plaster, Gypsum Board, Textured Surfaces Paint Table

A. Interior New Wallboard not otherwise specified

Institutional Low Odor / Low VOC Latex, New

Institutional Low Odor / Low VOC Latex				
New	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2M-G3 (Eggshell)	MPI 149	MPI 145	MPI 145	4 mils
MPI INT 9.2M-G4 (Satin)	MPI 149	MPI 146	MPI 146	4 mils
MPI INT 9.2M-G5 (Semigloss)	MPI 149	MPI 147	MPI 147	4 mils
Topcoat: Coating to match adjacent surfaces.				

B. Interior New Wallboard in restrooms not otherwise specified

Waterborne Light Industrial Coating					
New	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2L-G5(Semigloss)	MPI RIN 9.2L-G5 (Semigloss)	MPI 50	MPI 153	MPI 153	4 mils
Topcoat: Coating to match adjacent surfaces.					

Alkyd					
New, uncoated Existing	Existing, previously painted	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2C-G5 (Semigloss)	MPI RIN 9.2C-G5 (Semigloss)	MPI 50	MPI 47	MPI 47	4 mils
Topcoat: Coating to match adjacent surfaces.					

Epoxy, New

Epoxy				
New, uncoated Existing	Primer	Intermediate	Topcoat	System DFT
MPI INT 9.2E-G6 (Gloss)	MPI 50	MPI 77	MPI 77	4 mils
Topcoat: Coating to match adjacent surfaces.				

-- End of Section --

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HIGH PERFORMANCE COATING FOR STEEL STRUCTURES
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1200	(2010; R 2014) Viscosity by Ford Viscosity Cup
ASTM D1640/D1640M	(2014) Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings
ASTM D3276	(2015; E 2016) Standard Guide for Painting Inspectors (Metal Substrates)
ASTM D3335	(1985a; R 2020) Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
ASTM D3718	(1985a; R 2015) Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
ASTM D3925	(2002; R 2015) Sampling Liquid Paints and Related Pigmented Coatings
ASTM D4285	(1983; R 2018) Indicating Oil or Water in Compressed Air
ASTM D4417	(2021) Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM E11	(2022) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 8502-3	(2017) Preparation of Steel Substrates Before Application of Paints and Related Products - Tests for the Assessment of Surface Cleanliness - Part 3: Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method)
ISO 9001	(2015) Quality Management Systems-

Requirements

MASTER PAINTERS INSTITUTE (MPI)

MPI 515	(2020) Non-Zinc, Epoxy Barrier Coating, Flexible
MPI 516	(2020) Fluoropolyurethane, Steel Structure Exterior, Topcoat

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC AB 1	(2015; E 2017) Mineral and Slag Abrasives
SSPC AB 2	(2015; E 2016) Cleanliness of Recycled Ferrous Metallic Abrasive
SSPC AB 3	(2003; E 2004) Ferrous Metallic Abrasive
SSPC Guide 6	(2015) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations
SSPC Guide 12	(1998; E 2004) Guide for Illumination of Industrial Painting Projects
SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC PA 2	(2015; E 2018) Procedure for Determining Conformance to Dry Coating Thickness Requirements
SSPC QP 1	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Field Application to Complex Industrial Steel Structures and Other Metal Components)
SSPC QP 2	(2019) Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors (Removal of Hazardous Coatings from Structures)
SSPC QP 5	(2022) Standard Procedure for Evaluating the Qualifications of Coating and Lining Inspection Companies
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System
SSPC SP 1	(2015) Solvent Cleaning
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning
SSPC SP 11	(2012) Power Tool Cleaning to Bare Metal
SSPC VIS 1	(2002; E 2004) Guide and Reference

	Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A	(2017) Colors used in Government Procurement

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for
MIL-DTL-24441/19	(2009; Rev C) Paint, Epoxy-Polyamide, Zinc Primer, Formula 159, Type III
MIL-DTL-24441/31	(2009; Rev B; Notice 1 2021) Paint, Epoxy-Polyamide, White, Formula 152, Type IV
MIL-PRF-85285	(2012; Rev E; Notice 1 2016) Coating: Polyurethane Aircraft and Support Equipment
MIL-STD-161	(2015; Rev H) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910-SUBPART Z	Toxic and Hazardous Substances
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1000	Air Contaminants
29 CFR 1926.59	Hazard Communication

1.2 DEFINITIONS

Definitions are generally provided throughout this Section in the paragraphs where used and denoted by capital letters. The following definitions are used throughout this Section:

a. INDEPENDENT THIRD-PARTY - Impartial third-party not a part or affiliated with Contractor or subcontractor principal or subsidiary businesses, and not a materials supplier.

b. STRIPE COAT - An additional corrosion protection measure on edges, outside corners, crevices, bolt heads, welds, and other irregular surfaces, including minor surface preparation on sharp edges.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contract Errors, Omissions, and Other Discrepancies

Corrective Action Procedures

Corrective Action Request (CAR) Form

Coatings Work Plan

Inspection Report Forms

SD-05, Design Data

Containment System

SD-06 Test Reports

Coatings Qualification Test Reports

Ferrous Metallic Abrasive Qualification Test Reports

Non-Metallic Abrasive Qualification Test Reports

Coating Field Test Reports

Abrasive Field Test Reports

Recycled Ferrous Metallic Abrasive Field Test Reports (Daily and Weekly)

Daily Inspection Reports

SD-07 Certificates

Qualifications of Certified Industrial Hygienist (CIH)

Qualifications of Protective Coatings Specialist (PCS)

Qualifications of Coatings Inspection Company

Qualifications of Quality Assurance Coatings Inspector

Qualifications of Coatings Contractor Company

Qualifications of Individuals Performing Abrasive Blasting

Qualifications of Individuals Applying Coatings

Qualifications of Testing Laboratory for Coatings

Qualifications of Testing Laboratory for Abrasive

Coating Materials Certificate of Conformance

Non-Metallic Abrasive Certificate of Conformance

Ferrous Metallic Abrasive Certificate of Conformance

SD-08 Manufacturer's Instructions

Coating System Instructions

SD-11 Closeout Submittals

Disposal of Used Abrasive

Inspection Logbook; G, RO

Corrective Action Log; G, RO

1.4 QUALITY ASSURANCE

1.4.1 Contract Errors, Omissions, and Other Discrepancies

Submit all errors, omissions, and other discrepancies in contract documents to the Contracting Officer within 30 days of contract award for all work covered in this Section. All such discrepancies must be addressed and resolved, and the Coatings Work Plan modified, prior to beginning the Initial and Follow-Up phases of work.

Discrepancies that become apparent only after work is uncovered must be identified at the earliest discoverable time and submitted for resolution. Schedule time (float) must be built into the project schedule at those points where old work is to be uncovered or where access is not available during the first 30 days after award, to allow for resolution of contract discrepancies.

1.4.2 Corrective Action (CA)

CA must be included in the Contractor Quality Control Plan as outlined in Section QUALITY CONTROL.

1.4.2.1 Corrective Action Procedures

Develop procedures for determining the root cause of each non-compliance, developing a plan to eliminate the root cause so that the non-compliance does not recur, and following up to ensure that the root cause was eliminated.

1.4.2.2 Corrective Action Request (CAR) Form

Develop Corrective Action Request (CAR) forms for initiating CA and for tracking and documenting each step. The CAR should be included with the Corrective Action Procedures. A CAR must be initiated by either the Contractor or the Contracting Officer. The Protective Coatings Specialist (PCS) must approve each CAR at the root cause identification stage, the plan for elimination stage, and the close out stage after verification that the root cause has been eliminated.

1.4.2.3 Corrective Action Log

When a CAR is initiated, Contractor must take action to identify and eliminate the root cause of each non-compliance so as to prevent recurrence. These actions must apply to non-compliance in the work and to non-compliance in the Quality Control (QC) System. Corrective actions must be appropriate to the effects of the non-compliance encountered. The

corrective action must be documented in a report that is serialized and tracked in the Corrective Action Log until project completion and its acceptance by the Contracting Officer. All corrective action reports must be retained in project records. The Corrective Action Log, showing status of each CAR, must be submitted to the Contracting Officer monthly.

1.4.3 Coatings Work Plan

The Coatings Work Plan must be considered as part of the Contractor Quality Control Plan as outlined in Section QUALITY CONTROL.

The Coatings Work Plan must be submitted and approved by the PCS prior to mobilization. The Coatings Work Plan must explain in detail all procedures including, but not limited to, all sequential processes, quality control for each process, quality assurance for each process, and safety considerations. Subsections must include at least the following:

a. Purpose;

b. Introduction;

c. Safety, fire, and health information;

d. Contractor and worker qualifications with certifications;

e. Project management organization and documents;

f. Timeline in a Gantt chart;

g. Project document references;

h. Reference to all applicable standards (e.g., AMPP, NACE, SSPC, ISO, and ASTM);

i. Coatings manufacturer's supporting documentation;

j. Descriptions and explanations of any exceptions from the coating manufacturer;

k. Coating and blasting equipment, model names, and, if applicable, calibration dates;

l. Containment design and details;

m. Environmental testing;

n. Material delivery, storage, and handling details;

o. Surface preparation;

p. Pre-application test panel validation for field-applied external coating as outlined in SURFACE STANDARD;

q. Coating materials, mixing, application, recoat windows, and coating curing times, if applicable;

r. Coating repairs and rework;

s. Non-conformance;

t. Spent material handling and effluent discharge containment and disposal;

u. Inspection test plan (as outlined in FIELD INSPECTION, and including inspection hold points, both Quality Assurance and Coating Contractor QC Coatings Inspector's responsibilities, and daily documentation and delivery);

v. Instruments and test kits;

w. Warranty (in writing, signed by the Contractor and the coating manufacturer's representative);

x. Demobilization;

y. PCS and PM approval.

1.4.4 Design Data

1.4.4.1 Containment System

Submit complete design drawings and calculations for the scaffolding and containment system as described in paragraph CONTAINMENT, including an analysis of the loads which will be added to the structure by the containment system and waste materials. A registered engineer must approve calculations and scaffold system design.

1.4.5 Test Reports

1.4.5.1 Coatings Qualification Test Reports

Submit qualification test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each coating material. U.S. Department of Defense laboratories are considered to be independent laboratories. Samples must have been tested within the last three years. Samples must have been
tested within the last three years. Submit results for epoxy materials as required in paragraph QUALIFICATION INSPECTION of MIL-DTL-24441, and as revised by paragraph COATING SYSTEM herein. Submit results for polyurethane materials as required in paragraph QUALIFICATION INSPECTION of MIL-PRF-85285, and as revised by paragraph COATING SYSTEM herein. Note that requirement for QUALIFICATION INSPECTION is a pre-qualification requirement, and involves the same testing required for listing in the Qualified Products List of the respective material. See appropriate Military Specification for specific test requirement.

1.4.5.2 Ferrous Metallic Abrasive Qualification Test Reports

Submit qualification testing results for abrasive as required in paragraph 4 REQUIREMENTS of SSPC AB 3. Submit test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each abrasive to be used on the jobsite. Samples must have been tested within the last three years. Note that this testing is for the purpose of pre-qualifying the abrasive.

1.4.5.3 Non-Metallic Abrasive Qualification Test Reports

Submit results for abrasive as required in paragraph 4 REQUIREMENTS of

SSPC AB 1. Submit test results from an INDEPENDENT THIRD-PARTY laboratory of representative samples of each abrasive to be used on the jobsite. Samples must have been tested within the last three years. Note that this testing is for the purpose of pre-qualifying the abrasive.

1.4.5.4 Recycled Ferrous Metallic Abrasive Field Test Reports (Daily and Weekly)

Submit test results from an INDEPENDENT THIRD-PARTY laboratory of daily and weekly Quality Control testing required by SSPC AB 2, as modified in paragraph ABRASIVE.

1.4.6 Qualifications

1.4.6.1 Qualifications of Certified Industrial Hygienist (CIH)

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY CIH. Submit documentation that the hygienist is certified by the American Board of Industrial Hygiene in comprehensive practice, including certification number and date of certification/recertification. The CIH must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. If a CIH's certification expires, the hygienist will not be allowed to perform any hygienist functions, and all hygienist work must stop, until the certification is reissued or another CIH is approved. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Provide evidence of experience with hazards involved in industrial coating application work.

1.4.6.2 Qualifications of Protective Coatings Specialist (PCS)

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY PCS. Submit documentation that the PCS is certified by the Association for Materials Protection and Performance (AMPP) (formerly SSPC: The Society for Protective Coatings (SSPC)), including certification number and date of certification/recertification. If the PCS is employed by the same coatings inspection company to which the Quality Assurance Coatings Inspector is employed, this does not violate the INDEPENDENT THIRD-PARTY requirements. The PCS must remain certified during the entire project, and the Contracting Officer must be notified of any change in certification status within 10 days of the change. If a PCS's certification expires, the PCS will not be allowed to perform any PCS functions, and all coatings work must stop, until the certification is reissued or another PCS is approved. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. The PCS must not be the designated Quality Assurance Coatings Inspector. The PCS responsibilities are outlined in PROTECTIVE COATINGS SPECIALIST (PCS).

1.4.6.3 Qualifications of Coatings Inspection Company

Submit documentation that the coatings inspection company that will be performing all quality assurance coatings inspection functions is certified by AMPP to the requirements of SSPC QP 5 prior to contract award, and must remain certified while accomplishing any coatings inspection functions. The coatings inspection company that is submitted

and approved, must remain and cannot be changed through completion of the contract. The coatings inspection company must remain SSPC QP 5 certified for the duration of the coating work and the Contracting Officer must be notified of any change in certification status within 10 days of the change. If a coatings inspection company's certification expires, the firm will not be allowed to perform any inspection functions, and all surface preparation and coating application work must stop, until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of all scheduled and unannounced on-site audits from AMPP and furnish a copy of all audit reports. The coatings inspection company must not engage in any activities that may conflict with their independence of judgment and integrity in relation to their inspection activities. In particular, they must not be engaged in the manufacture, supply, application, surface preparation, purchase, or maintenance of the applied coating in this project.

1.4.6.4 Qualifications of Quality Assurance Coatings Inspector

Submit documentation that each Quality Assurance Coatings Inspector is employed by the SSPC QP 5 company and is qualified to a minimum certification of NACE CIP Level II. Each inspector must remain employed by the coatings inspection company while performing any coatings inspection functions. The Quality Assurance Coatings Inspector's responsibilities are outlined in QUALITY ASSURANCE COATINGS INSPECTOR'S FIELD RESPONSIBILITIES. The roles of the Quality Assurance Coatings Inspector are in addition to, and distinct from, the role of the QC Coatings Inspector employed by the coatings Contractor.

1.4.6.5 Qualifications of Coatings Contractor Company

All Contractors and Subcontractors that perform surface preparation or coating application must be certified to both SSPC QP 1 and SSPC QS 1 prior to contract award, and must remain certified while accomplishing any surface preparation or coating application. If a Contractor's or Subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in Contractor certification status. Notify the Contracting Officer of all scheduled and unannounced on-site audits from AMPP and furnish a copy of all audit reports.

For projects located outside the United States, Guam, and Puerto Rico, the certifications for the coatings Contractor (SSPC QP 1 and SSPC QS 1) can be substituted if the coatings Contractor meets all of the below requirements:

a. ISO 9001 certified;

b. Eight years of experience with industrial coatings;

c. Evidence of recent work that has Contractor Performance Assessment Report System (CPARS) ratings, or other quality/performance ratings, that are equivalent to, or exceed, "Above Average";

d. Evidence of an INDEPENDENT THIRD-PARTY audit from AMPP demonstrating

equivalency to SSPC QP 1 and SSPC QS 1 within the last two years.

e. Evidence of an INDEPENDENT THIRD-PARTY audit from AMPP demonstrating equivalency to SSPC QP 2 within the last two years.

The coatings Contractors and coatings Subcontractors must be certified to ISO 9001 prior to contract award and must remain so certified for the duration of the project. If a Contractor's or Subcontractor's certification expires, the firm will not be allowed to perform any work until the certification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in Contractor certification status. Notify the Contracting Officer of all scheduled and unannounced on-site inspections from the ISO certifying organization and furnish a copy of all inspection reports.

1.4.6.6 Qualifications of Individuals Performing Abrasive Blasting

Submit name, address, and telephone number of each person that will be performing abrasive blasting. Submit documentation that each blaster is qualified by AMPP to the SSPC C7 Dry Abrasive Blaster Qualification Program or the SSPC CAS Coating Application Specialist Level 2 Certification Program (Interim Status). Each blaster must remain qualified during the entire period of abrasive blasting, and the Contracting Officer must be notified of any change in qualification status within 10 days of the change. If a blaster's qualification expires, the blaster will not be allowed to perform any blasting functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply.

1.4.6.7 Qualifications of Individuals Applying Coatings

Submit name, address, and telephone number of each person that will be applying coatings. Submit documentation that each applicator is qualified by AMPP to the SSPC C12 Spray Application Certification or the SSPC CAS Coating Application Specialist Level 2 Certification Program (Interim Status). Each applicator must remain certified during the entire period of coating application, and the Contracting Officer must be notified of any change in qualification status within 10 days of the change. If an applicator's qualification expires, the applicator will not be allowed to perform any coatings application functions until the qualification is reissued. Requests for extension of time for any delay to the completion of the project due to an inactive qualification will not be considered and liquidated damages will apply.

1.4.6.8 Qualifications of Testing Laboratory for Coatings

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY laboratory or laboratories selected to perform testing of coating samples for qualification testing and for field sample testing for compliance with this Section. Submit documentation that the laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that the employees performing testing are qualified.

1.4.6.9 Qualifications of Testing Laboratory for Abrasive

Submit name, address, telephone number, fax number, and e-mail address of the INDEPENDENT THIRD-PARTY laboratory or laboratories selected to perform testing of abrasive for compliance with this Section. Submit documentation that the laboratory has experience in testing samples of abrasive for conformance with specifications, and that the employees performing testing are qualified.

1.4.6.10 Coating Materials Certificate of Conformance

Provide manufacturer's certification of conformance to MIL-DTL-24441 for the epoxy materials and MIL-PRF-85285 and as modified in this Section for polyurethane materials.

1.4.6.11 Ferrous Metallic Abrasive Certificate of Conformance

Provide manufacturer's certification of conformance that the materials are currently in conformance with SSPC AB 3 and as modified in this Section, and have been tested within the last three years.

1.4.6.12 Non-Metallic Abrasive Certificate of Conformance

Provide manufacturer's certification of conformance that the materials are currently in conformance with SSPC AB 1 and as modified in this Section, and have been tested within the last three years.

1.4.7 QA and QC Personnel

1.4.7.1 QC Manager

The QC Manager is as defined in Section QUALITY CONTROL.

1.4.7.2 Protective Coatings Specialist (PCS)

The PCS must be considered a QC Specialist and must report to the QC Manager, as specified in Section QUALITY CONTROL. The PCS must approve all submittals prior to submission to the QC Manager for approval or submission to the government for approval.

The PCS's responsibilities include, but are not limited to, the following:

a. Obtain, review, and understand all project documentation including, but not limited to, this Section,, Coatings Work Plan, inspection and testing plan (ITP), and all submittals before the project starts, during the project, and all coatings related re-work;

b. Attend all pre-job coatings meetings (in-person, phone, or virtually);

c. Attend pre-final coatings walk-through (mandatory) and attend final coatings walk-through (as required).

1.4.7.3 Quality Assurance Coatings Inspector

The Quality Assurance Coatings Inspector must be considered a QC Specialist and must report to the QC Manager, as specified in Section QUALITY CONTROL. The Quality Assurance Coatings Inspector must be present during all pre-preparation testing, surface preparation, coating application, initial cure of the coating system, during all coating repair

work, and during completion activities. The Quality Assurance Coatings Inspector must provide complete documentation of conditions and occurrences on the job site, and be aware of conditions and occurrences that are potentially detrimental to the coating system. The requirements for inspection listed in this Section are in addition to the QC inspection and reporting requirements specified in Section QUALITY CONTROL. The responsibilities of the Quality Assurance Coatings Inspector are defined in QUALITY ASSURANCE COATING INSPECTOR'S FIELD RESPONSIBILITIES. These responsibilities are separate and distinct from the responsibilities of the Coatings Contractor QC Coatings Inspector.

1.4.7.4 Coatings Contractor QC Coatings Inspector

The Coatings Contractor QC Coatings Inspector must stop non-compliant work. The responsibilities of the Coatings Contractor QC Coatings Inspector are defined in COATINGS CONTRACTOR QC COATINGS INSPECTOR'S FIELD RESPONSIBILITIES. These responsibilities are separate and distinct from the responsibilities of the Quality Assurance Coatings Inspector.

1.4.8 Pre-Application Meeting

After approval of submittals, but prior to the initiation of coatings work, Contractor representatives, including at a minimum, project superintendent, QC manager, paint foreman, Quality Assurance Coatings Inspector, and PCS must have a pre-application coating preparatory meeting. This meeting must be in addition to the pre-construction conference. Specific items addressed must include: corrective action requirements and procedures, coatings work plan, safety plan, coordination with other Sections, inspection standards, inspection requirements and tools, test procedures, environmental control system, safety plan, and test logs. Notify Contracting Officer at least ten days prior to meeting.

1.5 PRODUCT DATA

1.5.1 Coating System Instructions

Submit manufacturer's printed instructions including detailed mixing and application procedures, number and types of coats required, minimum and maximum application temperatures, and curing procedures. Include Safety Data Sheets (SDS) for materials to be used at the job site in accordance with 29 CFR 1926.59.

1.6 DELIVERY AND STORAGE

Ship, store, and handle materials in accordance with SSPC PA 1, and as modified in this Section. Maintain temperature in storage spaces between 40 and 85 degrees F, and air temperature more than 5 degrees F above the dew-point at all times. Inspect materials for damage prior to use and return non-compliant materials to manufacturer. Remove materials with expired shelf life from government property immediately and notify the Contracting Officer.

If materials are approaching shelf life expiration and an extension is desired, samples must be sent to the manufacturer, along with complete records of storage conditions, with a request for shelf life extension. If the manufacturer finds the samples and storage data suitable for shelf life extension, the manufacturer must issue an extension, referencing the product evaluation and the review of storage records. Products must not be extended longer than allowed in the product specification.

1.7 COATING HAZARDS

Ensure that employees are trained in all aspects of the safety plan. Specified coatings may have potential health hazards if ingested or improperly handled. The coating manufacturer's written safety precautions must be followed throughout mixing, application, and curing of the coatings. During all cleaning, cleanup, surface preparation, and paint application phases, ensure that employees are protected from toxic and hazardous chemical agents which exceed concentrations in 29 CFR 1910.1000. Comply with respiratory protection requirements in 29 CFR 1910.134. The CIH must approve work procedures and personal protective equipment.

1.8 JOB SITE REFERENCES

Make available to the Contracting Officer at least one copy of each standard to which coatings will be applied to under this Section, and an SSPC Certified Contractor Evaluation Form at the job site.

PART 2 PRODUCTS

2.1 COATING SYSTEM

Coating systems must be as specified herein; alternate systems will not be considered. Provide a complete system (primer, intermediate coat, and topcoat) material from one supplier and from one manufacturer.

Each coat must be a contrasting color between the preceding and subsequent coats.

2.1.1 Zinc-Rich Epoxy/Epoxy/Polyurethane Coating System

2.1.1.1 Zinc-Rich Epoxy Primer Coat

Epoxy polyamide, MIL-DTL-24441/19 (Formula 159, Type III).

2.1.1.2 Epoxy Intermediate Coat

Epoxy polyamide, MIL-DTL-24441/31 (Formula 152, Type IV, White (Tinted)). Tint to approximately SAE AMS-STD-595A color number 27778 parchment using pigment dispersions prepared for epoxy paint tinting. Manufacturer must tint material and appropriately label. All other requirements of this Military Specification apply.

2.1.1.3 Polyurethane Topcoat for Three-Coat System

Polyurethane coating topcoat of MIL-PRF-85285, Type II, B the Polyurethane top coat color shall be approved by the Base CE. Available color chips shall be submitted for selection with in 30 days of award.

Modify paragraph 3.6.4 of MIL-PRF-85285, Viscosity and Pot Life, as follows:

> The viscosity of the admixed coating, when tested in accordance with ASTM D1200 through a No. 4 Ford cup, must be as follows:

Time from mix (minimum)	Maximum time through a No. 4 Ford cup
Initially	30 seconds
2 hours	60 seconds
4 hours	No gel

Modify paragraph 3.7.1 of MIL-PRF-85285, Drying Time, as follows:

When applied by spray techniques and when tested in accordance with ASTM D1640/D1640M, the coating must be set-to-touch within four hours and dry-hard within eight hours.

2.2 COLOR IDENTIFICATION OF FUEL HANDLING AND STORAGE FACILITIES

Piping, conduit, and tank identification must be in accordance with MIL-STD-161. Mark direction of fluids in accordance with MIL-STD-161.

2.3 COATING FIELD SAMPLE COLLECTION KIT

Provide a kit for each sample to be collected. Each kit must contain: a 1 quart can for the base of the coating material; one appropriately sized can for the activator of the coating material; dipping cups for each component to be sampled; a shipping box sized for the samples to be shipped; and packing materials. Mark cans for the appropriate coating material and component (base or activator), including manufacturer's name, address, batch numbers, batch size shipped to the project site, and date of manufacture. Provide shipping documents, including either pre-paid shipping labels or a shipping number that can be used by the QC Manager to arrange pickup, addressed to the INDEPENDENT THIRD-PARTY testing laboratory.

2.4 ABRASIVE FIELD SAMPLE COLLECTION KIT

Provide a kit for each sample to be collected. Each kit must contain one suitable plastic bag or container for each sample to be collected. Mark containers with manufacturer's name, address, batch number, batch size, and date of manufacture. Provide shipping documents, including either pre-paid shipping labels or a shipping number that can be used by the QC Manager to arrange pickup, addressed to the approved INDEPENDENT THIRD-PARTY testing laboratory.

2.5 INSPECTION TEST KITS

2.5.1 Test Kit for Measuring Chloride, Sulfate, and Nitrate Ions on Steel and Coated Surfaces

Provide test kits that meet all of the following requirements:

a. Contains all materials,supplies, tools, and instructions for field testing and on-site quantitative evaluation of chloride, sulfate, and nitrate ions;

b. Extract solution is acidic, factory pre-measured, pre-packaged, and of uniform concentration;

c. Components and solutions are mercury free and environmentally friendly;

d. Contains new materials and solutions for each test extraction;

e. Contains an extraction test container (vessel, sleeve, cell) that creates a sealed, encapsulated environment during salt ion extraction;

f. Contains a test extract container suitable for testing the following steel surfaces: horizontal (up/down configuration), vertical, flat, curved, smooth, pitted, and rough;

g. All salt ion concentrations are directly measured in micrograms per square centimeter.

2.5.2 Test Kit for Measuring Chlorides in Abrasives

Provide test kits that meet all of the following requirements:

a. Is a completely self-contained test kit with all materials, supplies, tools, and instructions to take tests and identify results;

b. Uses identifiable, consistent, factory pre-measured test extract solution;

c. Provides for testing equal volumes of abrasive and test solution;

d. Provides for taking direct measurements of the chloride ion in parts per million (PPM), without using conversion charts or tables;

e. Provides all new components for extraction and titration for each test;

f. Provides a factory sealed titration device for each test;

g. Uses the extract sampling container as the titration container.

2.5.3 Test Kit for Identifying Amine Blush on Epoxy Surfaces

Provide test kits that meet all of the following requirements:

a. Is a completely self-contained field test kit with all materials, supplies, tools, and instructions to perform tests and indicate the presence of unreacted amines;

b. Uses an identifiable, consistent, uniform, pre-packaged, factory pre-measured indicating solution;

c. Contains no mercury or lead and is environmentally friendly;

d. Contains a solution of an unreacted amine for the purpose of "self checking" the indicator solution;

2.6 ABRASIVE

Use abrasive that is specifically selected to provide a sharp, angular profile to the specified depth. Abrasive must meet all requirements of this Section each time that it is placed in the blast pot. A maximum limit for soluble salt contamination (chloride) is specified herein; however, this maximum level of contamination does not guarantee that contamination will not be transferred to the steel surface during abrasive blasting. Other factors, such as on-site handling and recycling, can allow contamination of abrasive that can be transferred to the steel

surface. Contractors are cautioned to verify that the chosen abrasive, along with work and storage processes, allow the final surface cleanliness requirements to be achieved. Successful testing of contamination in abrasive does not negate the final acceptance testing of steel surfaces.

Abrasive material used must contain a maximum of one percent by weight of any toxic substance listed in Table Z-1, Z-2, or Z-3 of 29 CFR 1910-SUBPART Z, with the exception of inert or nuisance dust materials, arsenic, beryllium, cadmium, cobalt, lead, mercury, rhodium, silver, tellurium, thallium, and uranium.

Gross gamma radioactivity must not exceed 5 picocuries per gram.

2.6.1 Ferrous Metallic Abrasive

2.6.1.1 New and Remanufactured Steel Grit

New and remanufactured steel grit abrasive must conform to the chemical and physical properties of SSPC AB 3 Class 1 (Steel) only; Class 2 (Iron) abrasive must not be used. Modify the requirements of SSPC AB 3 to substitute the requirement in paragraph 4.2.2 CONDUCTIVITY for one chloride test as measured using the test kit described in this Section (paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES). The maximum allowable chloride content is 25 parts per million (PPM).

To develop a suitable work mix from new steel abrasive, a minimum of 200 to 400 recycles is required; therefore, it may be advantageous for a Contractor to use remanufactured steel grit or grit reclaimed from a previous project. Such grit must be traced to new grit conforming to SSPC AB 3 Class 1 and it meets all cleanliness requirements of SSPC AB 3 Class 1 when brought to the current jobsite. Submit one representative sample of this work mix to the INDEPENDENT THIRD-PARTY laboratory for testing, along with samples of new material. Acceptance and use of this work mix must not be used to justify any deviation from surface preparation requirements.

2.6.1.2 Recycled Steel Grit

Recycled steel grit abrasive media must conform to the chemical and physical properties of SSPC AB 2 except that:

a. The maximum allowable chromium and cadmium content of the work mix must be 0.1 percent by weight when tested in accordance with ASTM D3718 for chromium and ASTM D3335 for cadmium. Modify the requirements of SSPC AB 2 to add requirement for one chromate test and one cadmium test for each "LEAD" test required.

b. The maximum allowable chloride content is 25 parts per million (PPM) as measured with the test kit described in paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES. Modify the requirements of SSPC AB 2 to substitute requirement for one chloride test for each "WATER SOLUBLE CONTAMINANTS" test.

2.6.2 Non-Metallic Abrasive

Non-metallic abrasive must be graded to the appropriate surface profile range and must conform to the chemical and physical properties of SSPC AB 1, Class A except that:

a. The maximum allowable chromium and cadmium content of the work mix must be less than 0.1 percent by weight when tested in accordance with ASTM D3718 for chromium and ASTM D3335 for cadmium.

b. Must contain less than 7 PPM chlorides when tested with the kit provided in paragraph TEST KIT FOR MEASURING CHLORIDES IN ABRASIVES. Modify the requirements of SSPC AB 1 to substitute requirement for one chloride test for each "CONDUCTIVITY TEST" required in SSPC AB 1 (one random sample per 50 bags of abrasive or three random samples from each shipment, if abrasive is delivered in bulk).

2.7 WHITE ALUMINUM OXIDE NON-SKID GRIT

Size #60, dust free (washed and dry), minimum 99 percent pure, having the following sieve analysis when tested in accordance with ASTM E11 using a 2.2 pound sample:

Sieve #	Percent Retained
40	0
50	15-40
60	60-85

PART 3 EXECUTION

Perform all work, rework, and repair in accordance with approved procedures in the Coatings Work Plan. The Coatings Work Plan must be submitted and approved by the PCS prior to mobilization, in accordance with the paragraph entitled COATINGS WORK PLAN.

3.1 FIELD SAMPLE COLLECTION AND TESTING

Sample and test materials delivered to the jobsite as required in the subsequent subparagraphs. Notify the Contracting Officer three days in advance of sampling. The QC Manager, and either the PCS or Quality Assurance Coatings Inspector must witness all sampling.

3.1.1 Coating Field Sample Collection

Coatings that are qualified to MIL-DTL-24441 and MIL-PRF-85285MPI 515 and MPI 516 require one sample to be collected from each coating type used on-site. This sample must be collected and set aside for the duration of the project, and must be tested if unforeseen coatings issues arise or if testing is requested by the Contracting Officer. Coatings that are not qualified to MIL-DTL-24441 and MIL-PRF-85285MPI 515 and MPI 516 require a random field sample from each lot of coating material used on-site in accordance with ASTM D3925. Each random sample must be tested.

For sampling, utilize sample collection kits as outlined in the paragraph COATING FIELD SAMPLE COLLECTION KIT. Each sample must consist of 1 quart of base material, and a sample of the activator that is proportional to the mix ratio of the coating type. Prior to sampling, mix contents of each sealed container to ensure uniformity. As an alternative to collecting small samples from kits, entire kits may be randomly selected and shipped to the INDEPENDENT THIRD-PARTY laboratory, observing all requirements for witnessing and traceability. For purposes of quality

conformance inspection, a lot is defined as that quantity of materials from a single, uniform batch produced and offered for delivery at one time. A batch is defined as that quantity of material processed by the manufacturer at one time and identified by number on the label. Identify samples by designated name, specification number, batch number, project contract number, sample date, intended use, and quantity involved. If testing is required, the QC manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and ship one complete sample of each material in question (including base and activator) with all batch information to the INDEPENDENT THIRD-PARTY laboratory for testing as required in paragraph COATING FIELD TESTING REPORTS.

3.1.2 Abrasive Field Sample Collection

Utilize the sample collection kits as required in paragraph ABRASIVE FIELD SAMPLE COLLECTION KIT to obtain samples from each lot of abrasive delivered to site using the sampling techniques and schedule of one sample per every 50 bags for ferrous metallic abrasive, paragraph 4 REQUIREMENTS FOR RECYCLED WORK MIX ABRASIVES of SSPC AB 2 for recycled ferrous metallic abrasives, or paragraph 5.3 SAMPLING FOR QUALITY CONTROL TESTS of SSPC AB 1 for non-metallic abrasives.

For purposes of quality conformance inspection, a lot must consist of all abrasive materials of the same type from a single, uniform batch produced and offered for delivery at one time. The addition of any substance to a batch must constitute a new lot. Identify samples by designated name, specification number, lot number, project contract number, sample date, intended use, and quantity involved. The QC manager will take possession of the packaged samples, contact the shipping company to arrange for pickup, and relinquish the samples only to the shipping representative for shipment to the approved laboratory for testing required in paragraph ABRASIVE FIELD TEST REPORTS.

3.1.3 Coating Field Test Reports

Submit test results for each sample that requires testing in paragraph COATING FIELD SAMPLE COLLECTION. Test samples of primer, intermediate, and topcoat materials for compliance with requirements of MIL-DTL-24441 and MIL-PRF-85285. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

3.1.4 Abrasive Field Test Reports

Submit test results for each lot of abrasive delivered to the jobsite. Test samples of ferrous metallic abrasive to the requirements of paragraph 5.2 TEST PARAMETERS of SSPC AB 3, excluding paragraph 5.2.4 DURABILITY. Test samples of recycled ferrous metallic abrasives to the requirements of paragraph 4 REQUIREMENTS FOR RECYCLED WORK MIX ABRASIVES of SSPC AB 2. Test samples of non-metallic abrasive to the requirements of paragraph 5.3 SAMPLING FOR QUALITY CONTROL TESTS of SSPC AB 1. Reject entire lot represented by samples that fail one or more tests, select new lots, and test samples.

3.2 SURFACES TO BE COATED

Prepare surface and apply the complete coating system in the shop. Follow all temperature, humidity, and testing requirements listed herein.

Coat exterior surfaces of tank structure .

3.3 LIGHTING

Provide lighting for all work areas as prescribed in SSPC Guide 12.

3.4 ENVIRONMENTAL CONDITIONS

3.4.1 Containment

Design and provide a containment system for the capture, containment, collection, storage, and disposal of the waste materials generated by the work under this Section, to meet the recommendations of SSPC Guide 6, Class 1. Vapor concentrations must be kept at or below 10 percent of Lower Explosive Limit (LEL) at all times. Containment may be designed as fixed containment for complete structure or portable containment for sections of structure; however, containment must remain in any one place from beginning of abrasive blasting through initial cure of the coating. Waste materials covered by this paragraph must not include any material or residue from removal of coatings containing lead, chromium, cadmium, PCB, or any other hazardous material.

It is the Contractors responsibility to insure the feasibility and workability of the containment system. The Contractor must perform their operations and work schedule in a manner as to minimize leakage of the containment system. The containment system must be properly maintained and must not deviate from the approved drawings. If the containment system fails to function satisfactorily, the Contractor must suspend all operations, except those required to minimize adverse impact on the environment or government property. Operations must not resume until modifications have been made to correct the cause of the failure.

3.4.2 Automated Monitoring Requirements

Provide continuous monitoring of temperature, relative humidity, and dew point data at pertinent points on the structure during surface preparation, coating application, and initial cure. This data is does not suffice for documentation of conformity to surface conditions during application and cure of coating. Locate sensors to provide pertinent data during the surface preparation and coating application being performed, as well as the temperature extremes on the structure. Describe the location plan, including anticipated probe location changes, in the Coatings Work Plan. Monitor any heating, cooling, or dehumidification equipment used. Provide monitoring equipment to perform as follows:

a. Data is collected in the field unit in 15-minute increments, and available for download (on-site) in a standard database format. Contractor must collect these data and make it available to the Contracting Officer, Quality Assurance Coatings Inspector, and QC Manager;

b. Monitoring equipment must have backup power such that data collection will be uninterrupted during the entire period of the dehumidification requirement;

c. Monitoring equipment must have capability to measure surface temperatures at a minimum of four locations anywhere on a structure, regardless of the size of the structure;

d. Monitoring equipment must have capability to measure interior and exterior dry bulb temperature (DB), relative humidity (RH), and dewpoint temperature (DP).

There is no requirement for connectivity of the monitoring system to control any heating, cooling, or dehumidification equipment; therefore, any combination of equipment having the required functionality will be accepted.

3.5 SURFACE PREPARATION

Prepare steel surfaces in accordance with SSPC PA 1 and as specified herein.

3.5.1 Abrasive Blasting Equipment

Use abrasive blasting equipment of conventional air, force-feed, or pressure type. Maintain a minimum pressure of 95 psig at nozzle. Confirm that air supply for abrasive blasting is free of oil and moisture when tested in accordance with ASTM D4285. Test air quality at each startup, and at least every five operating hours.

3.5.2 Field Abrasive Contamination Testing

Test abrasive for salt contamination and oil contamination as required in SSPC AB 1 for non-metallic abrasives, SSPC AB 2 for recycled ferrous metallic abrasives, and SSPC AB 3 for ferrous metallic abrasives. Modify the schedule of testing to be daily, at startup, and every five operating hours thereafter.

3.5.3 Surface Standard

Inspect surfaces to be coated, and select plate with similar properties and surface characteristics for use as a surface standard. Blast clean one or more 1 foot square steel panels as specified in paragraph SURFACE PREPARATION. Record blast nozzle type and size, air pressure at nozzle and compressor, distance of nozzle from panel, and angle of blast to establish procedures for blast cleaning. Measure surface profile in accordance with ASTM D4417, Method C. When the surface standard complies with all specified requirements, seal with a clearcoat protectant. Use the surface standard for comparison to abrasive blasted surfaces throughout the course of work.

3.5.4 Pre-Preparation Testing for Surface Contamination

Perform testing, abrasive blasting, and testing in the prescribed order.

3.5.4.1 Pre-Preparation Testing for Oil and Grease Contamination

Inspect all surfaces for oil or grease contamination using two or more of the following inspection techniques:

a. VISUAL INSPECTION - Observe surface for evidence of dirt or oil.

b. WATER BREAK TEST - Spray atomized mist of distilled water onto surface and observe for water beading. If water wets surface rather than beading up, surface can be considered free of oil or grease contamination. Beading of water (water forms droplets) is evidence of oil or grease contamination.

c. CLOTH RUB TEST - Rub a clean, white, lint-free, cotton cloth onto surface and observe for discoloration. To confirm oil or grease contamination in lightly stained areas, a non-staining solvent may be used to aid in oil or grease extraction. Any visible discoloration is evidence of oil or grease contamination.

Reject oil or grease contaminated surfaces, clean using a water based, pH-neutral degreaser in accordance with SSPC SP 1, and recheck for contamination until surfaces are free of oil and grease.

3.5.4.2 Pre-Preparation Testing for Soluble Salts Contamination

Test all surfaces for soluble salts at rate of three tests for the first 1000 square feet, plus one test for each additional 2000 square feet, or part thereof. Perform 30 percent of tests on bare steel at welds, divided equally between horizontal and vertical welds. Label all test tubes and retain for test verification. Reject and wash surfaces if one or more readings greater than 3 micrograms per square centimeter of chlorides or 10 micrograms per square centimeter of sulfates or 5 micrograms per square centimeter of nitrates is measured.

Effective washing and removal of soluble salts will require removal of any barrier to the steel surface, including rust. This procedure may necessitate combinations of wet abrasive blasting, high pressure water rinsing, and cleaning using a solution of water and soluble salt remover. The soluble salt remover must be acidic, biodegradable, non-toxic, non-corrosive, and after application, will not interfere with primer adhesion. Use potable water, or potable water modified with soluble salt remover, for all washing or wet abrasive blasting. Additional testing is required when there are delays between testing and preparation or testing and coating application. Test methods and equipment used in this phase must be included in the Coatings Work Plan.

This phase is required because pre-preparation testing and washing are generally more advantageous than attempting to remove soluble salt contamination after abrasive blasting. Soluble salt testing is also required in paragraph PRE-APPLICATION TESTING FOR SOLUBLE SALTS CONTAMINATION as a final acceptance test of prepared surfaces after abrasive blasting. Successful completion of pre-preparation testing and washing does not negate the requirement for pre-application testing.

3.5.5 Abrasive Blasting

Abrasive blast steel surfaces to near-white metal in accordance with SSPC SP 10/NACE No. 2. Prepared surfaces shall conform to SSPC VIS 1 and shall match the prepared test-panels as specified in paragraph SURFACE STANDARD. Provide a 2 to 4 mil surface profile. Reject profile greater than 4 mils, discontinue abrasive blasting, and modify processes and materials to provide the specified profile. Measure surface profile in accordance with ASTM D4417, Method A and Method C. The appearance of the surface after blasting must have the appearance of a Sand or Grit comparator. A rounded profile shape or peened surface is not acceptable. Record all measurements required in this standard. Measure profile at rate of three test areas for the first 1000 square feet, plus one test area for each additional 1000 square feet, or part thereof. When surfaces are re-blasted for any reason, retest profile as specified. Following abrasive blasting, remove dust and debris by vacuum cleaning. Dust and debris tend to collect at welds, plate overlaps, and surface

irregularities. Do not attempt to wipe surface clean.

3.5.6 Disposal of Used Abrasive

Dispose of used abrasive off Government property in accordance with Federal, State, and Local mandated regulations.

3.5.7 Pre-Application Testing for Surface Contamination

3.5.7.1 Pre-Application Testing for Oil and Grease Contamination

Ensure surfaces are free of contamination as described in paragraph PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION, except that only questionable areas need to be checked for beading of water misted onto surface.

3.5.7.2 Pre-Application Testing for Soluble Salts Contamination

Test surfaces for soluble salt contamination using the test kit described in TEST KIT FOR MEASURING CHLORIDE, SULFATE, AND NITRATE IONS ON STEEL AND COATED SURFACES. Test all surfaces at rate of three tests for the first 1000 square feet, plus one test for each additional 2000 square feet, or part thereof. Perform 30 percent of tests on bare steel at welds, divided equally between horizontal and vertical welds. Label all test tubes and retain for test verification. One or more readings greater than 3 micrograms per square centimeter of chlorides or 10 micrograms per square centimeter of sulfates or 5 micrograms per square centimeter of nitrates is evidence of soluble salts contamination. Reject contaminated surfaces, wash as required in paragraph PRE-PREPARATION TESTING FOR SOLUBLE SALTS CONTAMINATION, allow to dry, and re-test until all required tests show acceptable results. Re-blast tested and cleaned areas as required. An atmospheric event, such as a coastal storm blowing onshore, can bring chloride contamination. Following an atmospheric event, spot testing must be accomplished to verify satisfactory conditions and to avoid intercoat contamination. Where visual examination or spot testing indicates contamination, perform sufficient testing to verify non-contamination, or to define extent of contamination for appropriate treatment.

3.5.7.3 Pre-Application Testing for Surface Cleanliness

Apply coatings to dust free surfaces. To test surfaces, use ISO 8502-3. Use a kit that is compliant with ISO 8502-3. A rating of 2 or better must be achieved for acceptance. If a test does not result in a rating of 2 or better, reject contaminated surfaces, clean by vacuum cleaning, and retest. Test surfaces at rate of three tests for the first 1000 square feet, plus one test for each additional 1000 square feet, or part thereof. Provide two additional tests for each failed test or questionable test. Document test results in the Daily Inspection Report and attach tape to the Inspection Logbook.

Ferrous abrasives may become magnetized and difficult to remove from the steel substrate. If ferrous abrasives are used, additional visual inspection must be performed to ensure no surface contamination by the abrasive is present.

3.6 MIXING AND APPLICATION OF COATING SYSTEM AND SEALANT

3.6.1 Preparation of Coating Materials for Application

Each of primer, intermediate, and topcoat materials is a two-component material supplied in separate containers and must be mixed at proper ratios prior to application.

3.6.1.1 Mixing Primer, and Intermediate Coat Materials

Mix in accordance with the approved coating system instructions, which may differ for each product. Do not alter mix ratios. Do not mix partial kits when using zinc primers. For the intermediate coat, do not use partial kits unless standardized measuring cups are utilized. All mixing processes must be witnessed by the Quality Assurance Coatings Inspector. Mix materials in same temperature and humidity conditions specified in paragraph DELIVERY AND STORAGE. Allow mixed material to stand for the required induction time based on temperature.

3.6.1.2 Mixing Topcoat Material

Mix in accordance with the coating system instructions, which may differ for each product. Do not mix partial kits unless standardized measuring cups are utilized. Do not alter mix ratios. All mixing processes must be witnessed by the Quality Assurance Coatings Inspector. Mix polyurethane coating materials in same temperature conditions specified in paragraph DELIVERY AND STORAGE. The polyurethane coating material is moisture sensitive and any introduction of moisture or water into the material during mixing or application will shorten usable pot life. Use a mixer that does not create a vortex. Do not add thinner unless specific written recommendation from the manufacturer is obtained. No induction time is required, only thorough agitation of the mixed material.

3.6.1.3 Pot Life

Apply mixed products within stated pot life for each product. Stop applying when material becomes difficult to apply in a smooth, uniform wet film. Add all required solvent at time of mixing, as allowable per the coating system instructions. Do not add solvent to extend pot life. Pot life is based on standard conditions at 70 degrees F and 50 percent relative humidity. For every 18 degrees F rise in temperature, pot life is reduced by approximately half, and for every 18 degrees F drop it is approximately doubled. Usable pot life depends on the temperature of the material at the time of mixing and the sustained temperature at the time of application. Other factors such as the shape of the container and volume of mixed material may also affect pot life. Pre-cooling or exterior icing of components for at least 24 hours to a minimum of 50 degrees F in hot climates will extend pot life. High humidity at time of mixing and application shortens pot life of the Polyurethane topcoat material. The approximate pot life for epoxy coating materials is four hours. The approximate pot life for polyurethane coating materials is two hours.

3.6.1.4 Application Conditions and Recoat Windows

The curing process for coating materials is time, temperature, and moisture sensitive. Application condition requirements help mitigate delamination problems frequently found on industrial structures.

a. Plan coating application to ensure that specified temperature, humidity, and condensation conditions are met. If conditions do not allow for orderly application of the coating system as outlined in APPLICATION OF COATING SYSTEM, use appropriate means of controlling air and surface temperatures, as required. Partial or total enclosures, insulation, heating or cooling, or other appropriate measures may be required to control conditions to allow for orderly application of all required coats. Enclosure design must be included in the Coatings Work Plan.

b. Maintain air and steel surface temperature within the range allowable by the coating system instructions during application and the first four hours of cure for epoxy coats and the first eight hours of cure for polyurethane coats. Maintain steel surface temperature more than 5 degrees F above the dew-point of the ambient air for the same period. These conditions may require environmental controls as described in paragraph CONTAINMENT.

c. If coating is not applied during the recoat window specified by the coating manufacturer, or if surface temperature exceeds the temperature recommended in the coating system instructions between applications, provide GLOSS REMOVAL. If the next planned coat is the topcoat, apply FILL COAT if required to fill sanding marks. Apply FILL COAT within 24 hours of GLOSS REMOVAL, then apply topcoat within RECOAT WINDOW of FILL COAT. The topcoat must be free of defects and be of uniform appearance in accordance with SSPC PA 1. Sanding marks from GLOSS REMOVAL of intermediate coat reflecting through topcoat will be considered as non-compliant. Lack of hiding by the finish coat must require additional applications to obtain uniform appearance.

d. FILL COAT - Where indicated, apply coat of non-zinc epoxy, at 2 to 3 mils DFT, then apply next specified full coat within recoat window of FILL COAT. A FILL COAT may be used to adjust coating thickness to comply with requirements or to fill sanding marks in non-zinc epoxy coat.

e. GLOSS REMOVAL - Where required, hand sand in a circular fashion to remove gloss using 120-200 grit wet/dry sandpaper, followed by solvent wiping with a clean rag soaked with denatured alcohol to remove all dust. GLOSS REMOVAL of primer and intermediate coats is to scarify surface. If steel is exposed during GLOSS REMOVAL, repair in accordance with paragraph PROCEDURE FOR HOLIDAY AND SPOT REPAIRS OF NEWLY APPLIED COATING. GLOSS REMOVAL of topcoat may include removal of up to 3 mils of coating to avoid excess thickness, prior to application of FILL COAT.

3.6.2 Amine Blush Testing of Epoxy Coat Prior to Overcoating

Test epoxy surfaces prior to application of subsequent coat for amine blush contamination using the test kit described in paragraph TEST KIT FOR IDENTIFYING AMINE BLUSH ON EPOXY SURFACES. Test all surfaces at rate of three tests for the first 1000 square feet, plus one test for each additional 2000 square feet, or part thereof. Remove any identified contamination using an approved procedure. If one or more tests show positive results for amine blush contamination, either treat all surfaces using the approved amine blush removal procedure or increase testing to ensure that all contamination is located, and then treat identified contamination using the approved procedure.

3.6.3 Application of Coating System

Apply coatings in accordance with SSPC PA 1 and as specified herein. Apply coatings to surfaces that meet all stated surface preparation requirements.

a. Intercoat contamination - After application of primer coat and prior to application of each subsequent coat, perform testing prescribed in paragraph PRE-APPLICATION TESTING FOR SURFACE CONTAMINATION to ensure minimal intercoat contamination. If contamination is detected, wash per SSPC SP 1 and re-inspect. This testing may be reduced to one half of the prescribed rate for bare steel if the testing indicates no contamination when sampling is evenly distributed over surfaces being tested. If contamination is found between coats, revert to the specified testing rate. An atmospheric event, such as a coastal storm blowing onshore, can bring chloride contamination. Following an atmospheric event, spot testing must be accomplished to verify satisfactory conditions and to avoid intercoat contamination. Where visual examination or spot testing indicates contamination, perform sufficient testing to verify non-contamination, or to define extent of contamination for appropriate treatment.

b. Application - Apply each coat in a consistent wet film, at 90 degrees to previous coat. Ensure that primer and intermediate coat cold joints are no less than 6 inches from welds. Apply STRIPE COAT by brush. For convenience, STRIPE COAT material may be delivered by spray if followed immediately with brush-out and approved procedures include appropriate controls on thickness. Apply all other coats by spray application. Use appropriate controls to prevent airborne coating fog from drifting beyond 15 feet from the structure perimeter . Cover or protect all surfaces that will not be coated. The cleanliness, temperature, recoat windows, and airborne paint containment requirements may necessitate the use of enclosures, portable shelters, or other appropriate controls such as those described in paragraph CONTAINMENT.

Apply coatings at the following specified thickness:

Coat	Minimum DFT (Mils)	Maximum DFT (Mils)
Primer	3	5
Intermediate	3	5
Top	2	3
Total system	8	13

3.6.3.1 Application of Zinc-Rich Epoxy Primer

Apply primer coat, maintaining paint supply container height within 3 feet of the paint nozzle for applying zinc primer. Maintain constant agitation of paint pot to ensure that zinc does not settle in container.

3.6.3.2 Application of STRIPE COAT for Three-Coat System

Apply a STRIPE COAT using the intermediate coating material within the recoat window of primer, allowing sufficient dry time to allow application of intermediate coat within recoat window of primer. Apply by brush,

working material into corners, crevices, angles, and welds, and onto outside corners and angles. The STRIPE COAT must be applied in a contrasting color to the primer and intermediate coats and extend a width of no less than 1.5 inches on each side of the feature being protected.

3.6.3.3 Application of Intermediate Coat

Apply intermediate coat within the recoat window of primer coat.

3.6.3.4 Non-skid for Stairs and Top

Where non-skid is required, apply a second non-zinc epoxy coat, and immediately follow with application of non-skid grit, broadcast at the rate of 2 pounds per 100 square feet, and backroll. Apply topcoat as specified.

3.6.3.5 Application of Topcoat

Make all required repairs to primer and intermediate coats as specified in paragraph PROCEDURE FOR HOLIDAY AND SPOT REPAIRS OF NEWLY APPLIED COATING prior to applying topcoat. Apply topcoat within recoat window of preceding coat. The polyurethane topcoat may require multiple passes to achieve desired aesthetics and required thickness. Consult manufacturer for application procedures for anticipated temperature, humidity, and wind conditions. Do not add thinner unless a specific written recommendation from the manufacturer is obtained. Touch-up blemishes and defects within recoat window of polyurethane topcoat. Retain sample of polyurethane topcoat, from the same batch used to coat structure, to make touch-ups that might be required later.

3.6.3.6 Procedure for Holiday and Spot Repairs of Newly Applied Coating

Repair coating film defects at the earliest practicable time, preferably before application of the succeeding coat. Observe all requirements for soluble salts contamination, cleanliness between coats, and application conditions. Prepare defective area in accordance with SSPC SP 10/NACE No. 2, and feather coating as required to leave 4 inches of each succeeding coat feathered and abraded. If spot locations are less than 0.5 percent of the surface area and no greater than 6 inches in diameter, SSPC SP 10/NACE No. 2 vacuum blasting or SSPC SP 11 using an impact tool may be allowed. Protect adjacent areas from damage and overspray. Remove dust and solvent wipe the prepared area, plus an additional 4 inches beyond the prepared area, with clean denatured alcohol. Apply each coat within recoat window of preceding coat. Within four hours of preparation, apply zinc-rich primer to prepared steel and feather onto prepared primer. Apply intermediate coat to primed area and feather to prepared intermediate area. Apply topcoat to intermediate coat and feather to prepared topcoat. Apply each repair coat to approximate thickness of surrounding coating system.

3.6.3.7 Structure Occupancy After Coating Application

Use clean canvas or other approved shoe covers when walking on coated surfaces, regardless of curing time allowed. For heavily trafficked areas, provide cushioned mats for additional protection.

3.7 FIELD QUALITY CONTROL

Project documentation, including inspection and testing records, must be

used to determine the Contractor's compliance with contract requirements and approved procedures. The Contractor's certifications of completion, for both invoices and for project completion, must be based on documented evidence of compliance with all requirements and approved Coatings Work Plan procedures. For marking of tank surfaces, use chalk for marking bare steel and water based markers for marking coated surfaces. Remove marks prior to coating. Do not use any wax or grease based markers, or any other markers that leave a residue or stain.

3.7.1 Field Inspection

3.7.1.1 Inspection Requirements

a. Perform field inspection in accordance with ASTM D3276 and the approved Coatings Work Plan.

b. Provide all tools and instruments required to perform the required testing, as well as any tools or instruments that the inspector considers necessary to perform the required inspections and tests. Document each inspection and test, including required hold points and other required inspections and tests, as well as those inspections and tests deemed prudent from on-site evaluation to document a particular process or condition, as follows:

(1) Location or area;

(2) Purpose (required or special);

(3) Method;

(4) Criteria for evaluation;

(5) Results;

(6) Determination of compliance;

(7) List of required rework;

(8) Observations.

c. Collect and record environmental conditions as described in ASTM D3276 on a 24 hour basis, as follows:

(1) During surface preparation, every hour, or when changes occur;

(2) During coating application and the first four days of initial cure, every hour, or when changes occur;

(3) Note location, time, and temperature of the highest and lowest surface temperatures each day;

(4) Use a non-contact thermometer to locate temperature extremes, then verify with contact thermometers.

d. Data collected on environmental conditions in AUTOMATED MONITORING REQUIREMENTS may be used for overnight data; however, the data must be constantly verified as to location of sensors and validity of data with respect to the coating work being accomplished.

e. Document all equipment used in inspections and testing, including manufacturer, model number, serial number, last calibration date and future calibration date, and results of on-site calibration performed. Work documented using data from equipment found to be out of calibration must be considered as non-compliant since last calibration or calibration check, as required.

f. Document Contractors compliance with the Coatings Work Plan.

3.7.1.2 Inspection Report Forms

Develop project-specific report forms as required to report measurements, test results, and observations being complete and conforming to contract requirements. This includes all direct requirements of the contract documents and indirect requirements of referenced documents. Show acceptance criteria with each requirement and indication of conformity of each inspected item. The data may be in any format, but must be legible and presented so that entered data can be quickly compared to the appropriate requirement.

3.7.1.3 Daily Inspection Reports

Submit one copy of daily inspection report completed each day, when performing work under this Section, to the Contracting Officer. Note all non-compliance issues, and all issues that were reported for rework in accordance with QC procedures of Section QUALITY CONTROL. Each report must be signed by the Quality Assurance Coatings Inspector and the QC Manager. Submit report within 24 hours of date recorded on the report.

3.7.1.4 Inspection Logbook

A continuous record of all activity related to this Section must be maintained in an Inspection Logbook on a daily basis. The logbook must be hard or spiral-bound book or digital program with consecutively numbered pages, and must be used to record all information provided in the Daily Inspection Reports, as well as other pertinent observations and information. Submit the original Inspection Logbook to the Contracting Officer upon completion of the project and prior to final payment.

3.7.1.5 Inspection Equipment

All equipment must be in good condition, operational within its design range, and calibrated as required by the specified standard for use of each device.

3.7.2 Coatings Contractor QC Coatings Inspector's Field Responsibilities

The Coatings Contractor QC Coatings Inspector responsibilities include complete documentation of all daily inspection and production activities for the entire coatings project as outlined in the Coatings Work Plan,, and this Section. This includes, but is not limited to, the following:

a. Attending and documenting the pre-job meeting and acquiring the, inspection and testing plan (ITP), schedule, and a list of who will receive the QC daily inspection reports;

b. Performing a project site walk-through with the Quality Assurance Evaluator (QAE) or asset owner, Coatings Contractor QC, QC Manager, and Quality Assurance Coatings Inspector, inspecting at least the

following:

(1) Asset(s) to be coated;

(2) Equipment and placement of equipment;

(3) Materials delivery and storage;

(4) Facility operational requirements during the project.

c. Perform all daily and hold point inspections including, but not limited to, the following:

(1) Check equipment, including blotter test to verify compressed air cleanliness;

(2) Perform non-visible contaminants testing (in accordance with PRE-PREPARATION TESTING FOR SOLUBLE SALT CONTAMINATION and PRE-APPLICATION TESTING FOR SOLUBLE SALT CONTAMINATION);

(3) Perform visible contaminants testing (in accordance with PRE-PREPARATION TESTING FOR OIL AND GREASE CONTAMINATION and PRE-APPLICATION TESTING FOR OIL AND GREASE CONTAMINATION);

(4) Obtain environmental readings;

(5) Perform abrasive field testing per SSPC AB 1, SSPC AB 2, or SSPC AB 3;

(6) Perform surface preparation monitoring and testing;

(7) Perform surface cleanliness testing;

(8) Perform dust quantity testing;

(9) Record materials storage documentation (record all coating and abrasive materials information, batch numbers, segregation, and storage temperature);

(10) Witness all coatings materials mixing and record mix materials temperatures, with verification of time of coatings pot life;

(11) Verify, witness, and record application method;

(12) Perform random wet film thickness (WFT) readings;

(13) Perform inspection of coatings application;

(14) Obtain dry film thickness (DFT) readings per SSPC PA 2;

(15) Observe label asset identification (label stickers);

(16) Write Correction Action Reports (CAR), if needed;

(17) Write Non-Conformance Reports (NCR), if needed.

d. Writing a daily detailed summary of the work shift inspections, testing, and the day's events, including any meetings and prevalent conversations. The final daily report must include a project summary

that must be part of the last daily coatings inspection report.

e. The Coatings Contractor QC Coatings Inspector must stop all non-compliant work.

3.7.3 Quality Assurance Coatings Inspector's Field Responsibilities

The Quality Assurance Coatings Inspector's field responsibilities include complete documentation of all on-site work associated with the coatings project. These responsibilities include, but are not limited to, the following:

a. Attending and documenting the pre-job meeting and acquiring the, ITP, schedule, and a list of who will receive the QC daily inspection reports;

b. Performing a project site walk-through with the QAE or asset owner, prime Contractor, and coatings Contractor (QC Coatings Inspector and QC Manager), inspecting at least the following:

(1) Asset(s) to be coated;

(2) Equipment and placement of equipment;

(3) Materials delivery and storage;

(4) Facility operational requirements during the project.

c. Verifying all daily and hold point inspections performed by the Coatings Contractor QC Coatings Inspector or QC Manager by performing mirror inspections including, but not limited to, the following:

(1) Verify equipment check, including blotter test to verify compressed air cleanliness;

(2) Verify visible contaminants testing;

(3) Take environmental readings;

(4) Perform surface preparation monitoring and testing;

(5) Perform surface cleanliness testing;

(6) Perform dust quantity test;

(7) Record materials storage documentation (record all coating and abrasive materials information, batch numbers, segregation, and storage temperature);

(8) Witness all coatings materials mixing and record mix materials temperatures, with verification of time of coatings pot life;

(9) Verify, witness, and record application method;

(10) Inspect coatings application;

(11) Perform dry film thickness (DFT) readings per SSPC PA 2;

(12) Inspect asset identification (label stickers);

(13) Write Correction Action Reports (CAR), if needed;

(14) Write Non-Conformance Reports (NCR), if needed.

d. The following testing is witnessed by the Quality Assurance Coatings Inspector and performed by the Coatings Contractor QC Coatings Inspector or QC Manager:

(1) Wet film thickness (WFT) readings by coatings applicator(s);

(2) Non-visible contaminants testing for chlorides, sulfates, and nitrates (CSN);

(3) Abrasive field testing per SSPC AB 1, SSPC AB 2, or SSPC AB 3.

e. Writing a daily detailed summary of the work shift inspections, testing, and the day's events, including any meetings and prevalent conversations. The final daily report must include a project summary that will be part of the last daily coatings inspection report.

3.8 FINAL CLEANUP

Following completion of the work, remove debris, equipment, and materials from the site. Remove all foreign matter such as blast media, dust, dirt, debris, grease, and oils. Wipe all dry to handle coated surfaces with damp lint-free cloth. Remove temporary connections to Government or Contractor furnished water and electrical services. Restore existing facilities in and around the work areas to their original condition.

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EXTERIOR SIGNAGE
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS C1.1M/C1.1	(2019) Recommended Practices for Resistance Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B108/B108M	(2019) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500	(2006) Metal Finishes Manual

1.2 GENERAL REQUIREMENTS

All exterior signage must be provided by a single manufacturer. Exterior signage must be of the design, detail, sizes, types, and message content shown on the drawings, must conform to the requirements specified, and must be provided at the locations indicated. Submit exterior signage schedule in electronic media with spread sheet format. Spread sheet must include sign location, sign type, and message. Signs must be complete with lettering, framing as detailed, and related components for a complete installation. Each sample must consist of a complete sign panel with letters and symbols. Samples may be installed in the work, provided each sample is identified and location recorded. Submit three color samples for each material requiring color and 12 inch square sample of sign face color sample.

1.2.1 Character Proportions and Heights

Letters and numbers on indicated signs for handicapped-accessible buildings must have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10. Characters and numbers on indicated signs must be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case letter "X". Lower case characters are permitted.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Approved Detail Drawings; G, RO

SD-03 Product Data

Modular Exterior Signage System

Installation

Exterior Signage; G, RO

SD-04 Samples

Exterior Signage; G, RO

SD-10 Operation and Maintenance Data

Protection and Cleaning;

1.4 QUALIFICATIONS

Signs, plaques, and dimensional letters must be the standard product of a manufacturer regularly engaged in the manufacture of the products. Items of equipment must essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

1.5 DELIVERY AND STORAGE

Materials must be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area in accordance with manufacturer's instructions.

1.6 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period must be provided.

PART 2 PRODUCTS

2.1 MODULAR EXTERIOR SIGNAGE SYSTEM

Exterior signage must consist of a system of coordinated directional, identification, and regulatory type signs located where shown. Dimensions, details, materials, message content, and design of signage must be as shown. Submit manufacturer's descriptive data and catalog cuts.

2.1.1 Panel And Post/Panel Type Signs

2.1.1.1 Posts

One-piece aluminum or galvanized steel posts must be provided with minimum 0.10 inch wall thickness. Posts must be designed to accept panel framing system described. The post must be designed to permit attachment of panel framing system without exposed fasteners. Caps must be provided for each post.

2.1.1.2 Panel Framing System

Panel framing consisting of aluminum sections and interlocking track components must be designed to interlock with posts with concealed fasteners.

2.1.1.3 Panels

Modular message panels must be provided in sizes shown on drawings. Panels must be fabricated a minimum of 0.090 inch aluminum .

2.1.1.4 Mounting

Provide permanent mounting by embedding posts in concrete foundation as indicated.

2.2 ALUMINUM ALLOY PRODUCTS

Aluminum alloy products must conform to ASTM B209 for sheet or plate, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings. Aluminum extrusions must be provided at least 1/8 inch thick and aluminum plate or sheet at least 16 gauge thick. Welding for aluminum products must conform to AWS C1.1M/C1.1.

2.3 ORGANIC COATING

Clean, prime and give surfaces a semi-gloss baked enamel or two-component acrylic polyurethane finish in accordance with NAAMM AMP 500, AMP 505, with total dry film thickness not less than 1.2 mils.

2.4 STEEL PRODUCTS

Structural steel products must conform to ASTM A36/A36M. Sheet and strip steel products must conform to ASTM A1011/A1011M. Welding for steel products must conform to AWS D1.2/D1.2M.

2.5 VINYL SHEETING FOR GRAPHICS

Vinyl sheeting must be 5 to 7 year premium type and must be in accordance with the flammability requirements of ASTM E84 and must be a minimum 0.003 inch film thickness. Film must include a precoated pressure sensitive adhesive backing, Class 1, or positionable pressure sensitive adhesive backing, Class 3.

2.6 ANCHORS AND FASTENERS

Exposed anchor and fastener materials must be compatible with metal to which applied and must match in color and finish and must be non-rusting, non-corroding, and non-staining. Exposed fasteners must be tamper-proof.

2.7 SHOP FABRICATION AND MANUFACTURE

2.7.1 Factory Workmanship

Work must be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled must be given a trial fit in the shop to ensure proper field assembly. Holes for bolts and screws must be drilled or punched. Drilling and punching must produce clean, true lines and surfaces. Welding to or on structural steel must be in accordance with AWS D1.1/D1.1M. Welding must be continuous along the entire area of contact. Exposed welds must be ground smooth. Exposed surfaces of work must have a smooth finish and exposed riveting must be flush. Fastenings must be concealed where practical. Items specified to be galvanized must be by hot-dip process after fabrication if practical. Galvanization must be in accordance with ASTM A123/A123M and ASTM A653/A653M, as applicable. Other metallic coatings of steel sheet must be in accordance with ASTM A924/A924M. Joints exposed to the weather must be formed to exclude water. Drainage and weep holes must be included as required to prevent condensation buildup.

2.7.2 Dissimilar Materials

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces must be protected

with a coat of asphalt varnish or a coat of zinc-molybdate primer to prevent galvanic or corrosive action.

2.7.3 Shop Painting

Surfaces of miscellaneous metal work, except nonferrous metal, corrosion resisting steel, and zinc-coated work, must be given one coat of zinc-molybdate primer or an approved rust-resisting treatment and metallic primer in accordance with manufacturer's standard practice. Surfaces of items to be embedded in concrete must not be painted. Upon completion of work, damaged surfaces must be recoated.

2.8 COLOR, FINISH, AND CONTRAST

Color must be as indicated on the drawings. Where color is not indicated on the drawings, select from manufacturers standard colors and coordinate with CES. For buildings required to be handicapped-accessible, the characters and background of signs must be eggshell, matte, or other non-glare finish. Characters and symbols must contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 EXECUTION

3.1 INSTALLATION

Signs, plaques, or dimensional letters must be installed in accordance with approved manufacturer's instructions at locations shown on the approved detail drawings; submit drawings showing elevations of each type of sign; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction. Signs must be installed plumb and true at mounting heights indicated, and by method shown or specified. Signs mounted on other surfaces must not be installed until finishes on such surfaces have been completed. Submit manufacturer's installation instructions and cleaning instructions.

3.1.1 Anchorage

Anchorage and fastener materials must be in accordance with approved manufacturer's instructions for the indicated substrate. Anchorage not otherwise specified or indicated must include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.

3.1.2 Protection and Cleaning

The work must be protected against damage during construction. Hardware and electrical equipment must be adjusted for proper operation. Glass, frames, and other sign surfaces must be cleaned in accordance with manufacturer's instructions. After signs are completed and inspected, cover all project identification, directional, and other signs which may mislead the public. Covering must be maintained until instructed to be removed by the Contracting Officer or until the facility is to be opened for business.

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INTERIOR SIGNAGE
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DAF45	(2003; Reaffirmed 2009) Designation System for Aluminum Finishes
AA PK-1	(2015) Pink Sheets: Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings & Ingot

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 2604	(2017a) Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2021) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM D635	(2018) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

INTERNATIONAL CODE COUNCIL (ICC)

ICC/ANSI A117.1	(2009) Accessible and Usable Buildings and Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2024) Life Safety Code

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 800-82	(2015; Rev 2) Guide to Industrial Control Systems (ICS) Security

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems
DODI 8500.01	(2014) Cybersecurity
UFC 4-010-06	(2016; with Change 1, 2017) Cybersecurity of Facility-Related Control Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, DO

SD-03 Product Data

Room Identification Signage System; G, DO

Exit Door Tactile Sign; G, DO

Door Tags; G, RO

SD-04 Samples

Interior Signage; G, DO

Room Identification Signage System; G, DO

= Exit Door Tactile Sign; G, DO

Door Tags; G, RO

SD-10 Operation and Maintenance Data

Approved Manufacturer's Instructions; G, RO

Protection and Cleaning; G, RO

1.3 QUALITY ASSURANCE

1.3.1 Samples

Submit interior signage samples of each of the following sign types showing typical quality, workmanship and color: all sign types included in project . Approved samples may be installed in the work, provided each sample is identified and location recorded.

1.3.2 Detail Drawings

Submit detail drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, mounting height, shape and thickness of materials, and details of construction. Include a schedule showing the location, each sign type, and message.

1.3.3 Sign Fabricator

Sign Fabricator to follow room number strategies created by designer. The room numbering system to be reviewed and approved by the Contracting Officer and command end users during the shop drawing phase, and prior to fabrication.

1.3.4 Cybersecurity

a. The Risk Management Framework (RMF) is the process by which information systems are accredited for operation by a designated official from the Using Military Department. It is the standard process under which all DoD information systems achieve and maintain their Authority To Operate. The cybersecurity process is documented in DOD 8510.01 and NIST SP 800-82. Refer to UFC 4-010-06 and DODI 8500.01 for additional requirements.

b. All systems that are IP addressable or interface with the Assured Network required certification to operate. Coordinate with the Government to initiate and complete the accreditation process.

c. Cybersecurity requires input from the system vendor or provider and support from the local IMD. The local IMD-IA office is the point of contact for all Cyber Security requirements. The local CMIO is the point of contact for all clinical and functional system requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

Package materials to prevent damage and deterioration during shipment, handling, storage and installation. Deliver products to the jobsite in manufacturer's original packaging and store in a clean, dry area in accordance with manufacturer's instructions.

1.5 WARRANTY

Provide manufacturer's warranty to repair or replace defective interior signage materials and workmanship for a period of 2 years from date of final acceptance of the work.

PART 2 PRODUCTS

2.1 ROOM IDENTIFICATION SIGNAGE SYSTEM

Provide signs that are standard products of manufacturers regularly engaged in the manufacture of such products that essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening. Obtain signage from a single manufacturer with edges and corners of finished letter forms and graphics true and clean.

2.1.1 Standard Room Signs

Provide signs that include tactile letters, symbols and Braille for interior rooms or spaces where the sign is not likely to change over time. Tactile text descriptions are required for pictograms that are provided to identify a permanent room. Examples include interior signs that label restrooms, stairs, room numbers or letters, and room names. These permanent room signs can include paper inserts for updatable information.

2.1.1.1 Tactile Letters, Symbols and Braille

Provide ADA compliant material per 36 CFR 1191 which is raised 1/32 inch from the first surface, has a minimum 5/8 inch in height and is an ADA acceptable font. The color of the tactile letters is required to contrast with the sign face color per ADA standards. The ADA required Braille has a minimum durometer reading of 90. All raised letters, numbers and symbols are to comply.

2.1.2 Type of Mounting for Signs

Provide surface mounted signs mounted with concealed mechanical fastening through the holders. Secure inserts in holders with flexible plastic clips .

2.1.3 Character Proportions and Heights

Letters and numbers on signs conform to 36 CFR 1191.

2.2 EXIT DOOR TACTILE SIGN

Provide tactile sign with the message EXIT at each exit door that requires an exit sign to conform with NFPA 101. Sign tactile message is to comply with ICC/ANSI A117.1.

2.3 DOOR TAGS

Provide one door tag plate for each room entry door. Provide room number to match architectural floor plan room number.

2.3.1 Engraved Copy

Machine engrave letters, numbers, symbols, and other graphics into panel sign on face to produce precisely formed copy and sharp images, incised to uniform depth. Melamine plastic engraving stock used for ADA compliant graphic is three-ply lamination contrasting color core meeting ASTM D635.

2.4 MATERIALS

2.4.1 Aluminum Alloy Products

Aluminum extrusions are at least 1/8 inch thick, and aluminum plate or sheet are at least 0.0508 inch thick. Extrusions conform to ASTM B221; plate and sheet conforms to ASTM B209. Where anodic coatings are specified, alloy conforms to AA PK-1 alloy designation 514.0. Exposed anodized aluminum finishes are as shown. Welding for aluminum products conforms to AWS D1.2/D1.2M.

2.4.2 Anodic Coating

Anodized finish conforms to AA DAF45 as follows:

a. Clear (natural) designation AA-M10-C22-A31, Architectural Class II 0.4 mil or thicker.

2.4.3 Organic Coating

Organic coating conforms to AAMA 2604, with total dry film thickness not less than 1.2 mils.

2.4.4 Plastic Laminate Sheet

ANSI/NEMA LD 3, general purpose HGS grade, 0.048 inch nominal thickness.

2.4.5 Fabrication and Manufacture

2.4.5.1 Factory Workmanship

Holes for bolts and screws are drilled or punched. Drilling and punching produces clean, true lines and surfaces. Exposed surfaces of work have a smooth finish; exposed riveting is flush. Conceal fastenings where practicable.

2.4.5.2 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces prevent galvanic or corrosive action.

2.4.6 Typeface

ADA-ABA compliant font for Room Signs.

2.5 GRAPHICS

Provide signage graphics for modular signs to the following:

2.5.1 Photopolymer

Integral graphics and Braille achieved by photomechanical stratification processes. Provide photopolymer used for ADA compliant graphics of the type that has a minimum durometer reading of 90. Tactile graphics are raised 1/32 inch from the first surface of plaque by photomechanical stratification process.

2.6 COLOR, FINISH, AND CONTRAST

Provide color as specified in Section 09 06 00 SCHEDULES FOR FINISHES as indicated; colors listed are not intended to limit the selection of equal colors from other manufacturers. Finish of eggshell, matte, or other non-glare finish for all signs as required in handicapped-accessible buildings.

PART 3 EXECUTION

3.1 PLACEMENT SCHEDULE

SIGNAGE PLACEMENT SCHEDULE			
Door/Room Number	Sign Type	Permanent Text	Symbol/Remarks
100	E1	No Smoking Within 50 feet of Building	Exterior Sign
101	A	Readiness	Interior Sign
102	DWM	Unisex Restroom	Interior Sign
103	A	Tele/Fa	Interior Sign
104	A	Electrical Room	Interior Sign
105	A	Mechanical Room	Interior and Exterior Signs
106	A	Genenerator A	Exterior Sign
106	G2	Generator Floor Maximum Vehicle weight 36 kips	Interior Sign
107	A	Tool Storage	Interior Sign
108	A	Workshop	Interior and Exterior Signs
110	A	Pump Control A	Interior Sign
110	G2	No Storage Allowed on Deck	Interior Sign
110	G1	Allowable Safe Loading on Metal grating 200 p.s.f.	Interior Sign
111	A	Day Tanks A	Interior Sign

SIGNAGE PLACEMENT SCHEDULE			
111	G2	No Storage Allowed on Deck	Interior Sign
111	G1	Allowable Safe Loading on Metal grating 200 p.s.f.	Interior Sign
112	A	Distro A	Interior Sign
113	A	Fire Pump	Exterior Sign
114	A	Switchgear UA	Interior and Exterior Signs
115	A	Switchgear GA	Interior and Exterior Signs
116	A	Exhaust Treatment	Interior Sign
116	G2	No Storage Allowed on Deck	Interior Sign
116	G1	Allowable Safe Loading on Metal grating 200 p.s.f.	Interior Sign
117	A	Generator B	Exterior Sign
117	G2	Generator Floor Maximum Vehicle weight 36 kips	Interior Sign
118	A	Switchgear GB	Interior and Exterior Signs
119	A	Switchgear UB	Interior and Exterior Signs
120	A	Distro B	Interior and Exterior Signs
121	A	Forklift Charging	Interior Sign
122	A	New Oil Storage	Interior Sign
123	A	Pump Control B	Interior Sign
123	G2	No Storage Allowed on Deck	Interior Sign

SIGNAGE PLACEMENT SCHEDULE			
123	G1	Allowable Safe Loading on Metal grating 200 p.s.f.	Interior Design
124	A	Day Tanks B	Interior Sign
124	G2	No Storage Allowed on Deck	Interior Sign
124	G1	Allowable Safe Loading on Metal grating 200 p.s.f.	Interior Sign
201	G1	Allowable Safe Loading 125 p.s.f.	Interior Sign
202	G1	Allowable Safe Loading 125 p.s.f.	Interior Sign

3.2 INSTALLATION

Install signs plumb and true and in accordance with approved manufacturer's instructions at locations shown on the schedule above . Submit operating instructions outlining the step-by-step procedures required for system operation. The instructions include simplified diagrams for the system as installed, the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Provide each set permanently bound with a hard cover. The following identification must be inscribed on the covers: "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the facility, name of the Contractor, and contract number. Submit in accordance with Section 01 78 23 OPERATING AND MAINTENANCE DATA. Mounting height and mounting location complies with 36 CFR 1191. Install required blocking. Do not install signs on doors or other surfaces until finishes on such surfaces have been installed. Signs installed on glass surfaces are installed with matching blank back-up plates in accordance with manufacturer's instructions.

Do not install items that show visual evidence of biological growth.

3.2.1 Anchorage

Provide anchorage in accordance with approved manufacturer's instructions. Anchorage not otherwise specified or shown includes slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood. Provide exposed anchor and fastener materials compatible with metal to which applied with

matching color and finish.

a. Signs mounted to painted gypsum board surfaces must be removable for painting maintenance.

b. Mount signs to lay-in ceiling grids with clip connections to ceiling tees.

c. Install signs mounted on metal surfaces with magnetic tape.

d. Install signs mounted on fabric surfaces with hook and loop tape or pin mount.

e. Install signs to workstation panels with panel clips.

3.2.2 Protection and Cleaning

Protect the work against damage during construction. Adjust hardware and electrical equipment for proper operation. Clean glass, frames, and other sign surfaces at completion of signage installation in accordance with the manufacturer's written instructions.

-- End of Section --

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WIRE MESH PARTITIONS

08/24

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WIRE MESH PARTITIONS
08/24

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A510/A510M	(2020) Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC-ES AC70	(2019; R2021) Power-actuated Fasteners Driven into Concrete, Steel and Masonry Elements

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wire Mesh Partitions G, RO

SD-03 Product Data

Wire Mesh PartitionsG, DO

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials in manufacturer's original, unopened containers or packaging with labels intact and legible. Deliver, store, and handle materials so as to prevent damage. Replace damaged or defective materials with new.

1.4 DESCRIPTION OF WORK

Wire mesh partitions must be all wire type, normal duty for normal industrial use. Provide partitions complete with fasteners, capping bars, adjustable floor sockets,bracing, doors, hardware, and other items necessary for a complete, useable, and rigid installation. Verify field information and any penetration sizes and locations prior to preparing shop drawings. Show layout, details, materials, dimensions, finishes, and all information necessary for fabrication and installation.

PART 2 PRODUCTS

2.1 MATERIALS

Metal post and framing materials listed below must contain a minimum o 15 percent post-consumer recycled content and wire materials must contain a minimum of 50 percent post-industrial recycled content. Provide data identifying percentage of recycled content for metal post and framing materials for posts and wire material.

2.1.1 Steel Shapes, Plates, and Bars

ASTM A36/A36M and ASTM A53/A53M.

2.1.2 Cold-Formed Steel

AISI SG03-3 and ASTM A1008/A1008M.

2.1.3 Wire Mesh

ASTM A510/A510M carbon steel wire, woven diamond mesh, intermediate crimped.

2.1.4 Floor Sockets

Cast or forged steel or ductile iron, adjustable, approximately 2-1/2 inches high.

2.1.5 Color

Color shall be manufacturer's standard black. If black is not available, submit color chart of manufacturer's standard colors to select from.

2.2 NORMAL DUTY PARTITIONS

2.2.1 Wire Mesh

10 gage wire, 1-1/2 inch mesh.

2.2.2 Vertical Frames

1-1/4 by 5/8 inch cold-rolled C section channels or 1-1/4 by 5/8 by 1/8 inch channels.

2.2.3 Horizontal Frames

1 by 5/8 inch channels.

2.2.4 Center Reinforcing Bar

One 1 by 1/2 by 1/8 inch channel with all wires woven through, or two 1 by 3/8 by 1/8 inch channels bolted together with mesh in between.

2.2.5 Capping Bar

2-1/4 by 1 by 1/8 inch channel or 2 by 1/4 inch flat bar.

2.2.6 Corner Posts

Structural steel angles, 1-1/4 by 1-1/4 by 1/8 inch.

2.2.7 Line Posts

Unless otherwise indicated, provide partitions more than 12 feet high with flat bar line posts bolted between vertical frame channels. Sizes of posts must be as follows:

Partition Height	Size of Posts
12 feet to 14 feet 8 inches	1-3/4 by 5/16 inch or 2 by 1/4 inch
14 feet 8 inches to 19 feet 8 inches	2-1/2 by 5/16 inch
19 feet 8 inches to 23 feet 8 inches	3 by 5/16 inch

2.2.8 Hinged Doors

Frames must be 1-1/4 by 1/2 by 1/8 inch channels with 1-1/4 by 1/8 inch flat bar cover on top and bottom rails and on hinge stile and a 1-3/8 by 3/4 by 1/8 inch angle riveted to the lock stile. Provide 1-1/2 pairs of regular weight, wrought steel, non-removable pin, butt hinges riveted or welded to the door and the door opening frame for each door.

2.2.9 Sheet Metal Base

Hot- or cold-rolled sheet steel, not lighter than 16 gage.

2.3 HEAVY DUTY PARTITIONS

2.3.1 Wire Mesh

6 gage wire, 2 inch mesh.

2.3.2 Panel Frames

1-1/2 by 3/4 by 1/8 inch steel channels.

2.3.3 Center Reinforcing Bar

One 1-1/2 by 3/4 by 1/8 inch channel with all wires woven through, or two 1-1/4 by 3/8 by 1/8 inch channels bolted together with mesh in between.

2.3.4 Capping Bar

Structural steel channel, 3 inch by 4.1 pounds.

2.3.5 Corner Posts

Structural steel angles, 1-3/4 by 1-3/4 by 1/8 inch.

2.3.6 Line Posts

Unless otherwise indicated, provide partitions with flat bar line posts bolted between vertical frame channels. Sizes of posts must be as follows:

Partition Height	Size of Posts
7 feet to 12 feet	2-1/2 by 5/16 inch
12 feet to 16 feet	3 by 5/16 inch or 2-1/2 by 3/8 inch
16 feet to 20 feet	3-1/2 by 5/16 inch

2.3.7 Hinged Doors

Frames must be 1-1/2 by 3/4 by 1/8 inch channels with 1-1/2 by 1/8 inch flat bar cover on top and bottom rails and on hinge stile and a 1-5/8 by 7/8 by 1/8 inch angle riveted to the lock stile. Provide 1-1/2 pairs of heavyweight, wrought steel, non-removable pin, butt hinges riveted or welded to the door and the door opening frame for each door. Door shall be at least 3' wide by 7' high.

2.4 DOOR OPENING FRAMES

Provide frames the same size and shape as the vertical frames for the mesh panels.

2.5 LOCKS

Provide each door with a mortise type lock with a six-pin tumbler lock cylinder on the outside and a recessed knob on the inside.

2.6 FABRICATION

2.6.1 Standard Panels

Wire must be woven into diamond mesh, intermediate crimped, and securely clinched to frames. Joints must be mortised and tenoned. Wire must be continuous at center reinforcing bars, either woven through a single channel or bolted between two channels. Panel vertical frames must have 1/4 inch bolt holes 12 inches o.c. for normal duty partitions.

2.6.2 Sheet Metal Base Panels

Upper portion must be as specified for standard panels, except that the wire must be clinched into the center reinforcing bar. Form sheet steel

to fit between the panel frames and securely bolt to the frames.

2.6.3 Doors

Construction must be similar to that specified for panels. Wire mesh must be the same as that used in the adjacent partition panels.

2.6.4 Lateral Supports

Provide lateral bracing.

2.6.5 Penetrations

Provide cut-outs for any penetration (i.e., pipes, ducts, conduit, structural members) of the wire mesh as required. Frame cut-outs with 1 inch box channel. Fabricate penetration openings to prevent contact between penetrations and wire mesh partitions.

2.6.6 Post Shoes

Provide manufacturer's standard cast or fabricated metal shoes factory prepared with fastener holes. Provide corrosion protection and finish at shoes to match posts. Provide shoes that allow for vertical adjustability to accommodate floor flatness tolerances.

2.6.7 Fasteners

Manufacturer's standard steel machine bolts, washers, and nuts of type suited to use and strength to withstand required loads between components. Provide with lock-nuts/lock-washers as required to prevent loosening.

Provide post-installed fasteners suitable to surrounding construction sized to provide no less than six times the required load at masonry and no less than four times the required load at concrete. Provide ASTM E488/E488M metallic coated fasteners at interior locations.

Provide ICC-ES AC70 power-actuated fasteners for attachment in concrete.

2.6.8 Finish

Thoroughly clean ferrous metal, treat with phosphate, and paint with black enamel over suitable primer in the shop. Provide primer type(s) as directed by the paint manufacturer for each substrate and paint.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Wire Mesh Partitions

Install plumb, level, and true to line, within a tolerance of 1/8 inch in 10 feet or the height or run of the partition, if less than 10 feet. Anchor floor sockets to the floor with expansion bolts. Bolt vertical frames and posts together with 1/4 inch bolts 12 inches o.c. for normal duty partitions. Secure top frames to a continuous capping bar with 1/4 inch diameter U bolts not more than 28 inches o.c.

3.1.2 Doors

Install in accordance with the manufacturers' recommendations. Adjust as required so that doors and hardware operate freely and properly.

3.1.3 Bracing

Brace free standing partitions more than 20 feet in length, at intervals not greater than 20 feet with a steel channel brace connected to the capping bar and anchored to the building wall or framing member.

3.1.4 Touch-Up

Clean and paint scratches, abrasions, and other damage to shop painted surfaces to match the shop-applied finish.

Repair minor surface rust areas. Clean and prime with rust inhibitive primer paint. Apply final paint to match shop-applied finishes.

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TOILET ACCESSORIES

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2.1.6 Item A5145 Hook, Garment, Double, SS, Surface Mounted
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PART 3 EXECUTION

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TOILET ACCESSORIES
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-1691	(1994; Rev F) Construction and Material Schedule for Military Medical and Dental Facilities

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Item A5083 Dispenser, Paper Towel, Surface mounted; G, RO
Item A5109 Grab Bar, 1-1/4 inch Dia., SS, 2 Wall, W/C Accessible; G, RO
Item A5135 Shelf, Utility W/ Mop/Broom Holders, SS, Surf Mntd; G, RO
Item A5145 Hook, Garment, Double, SS, Surface Mounted; G, RO

Item A5195 Dispenser, Toilet Tissue, SS, 1-Roll, Surface Mntd; G, RO

1.3 DELIVERY, STORAGE, AND HANDLING

Wrap toilet accessories for shipment and storage, then deliver to the jobsite in manufacturer's original packaging, and store in a clean, dry area protected from construction damage and vandalism.

1.4 WARRANTY

Provide manufacturer's warranty to repair or replace defective materials and workmanship for a period of one year from date of final acceptance of the work..

PART 2 PRODUCTS

2.1 ACCESSORY ITEMS

Provide toilet accessories where indicated. Conform to the requirements for accessory items specified herein which are based on MIL-STD-1691 Joint Schedule Numbers (JSN). Provide each accessory item complete with the necessary mounting plates of sturdy construction with corrosion resistant surface.

Provide stainless steel products listed herein manufactured from materials containing a minimum of 50 percent recycled content.

2.1.1 Anchors and Fasteners

Provide corrosion-resistant anchors and fasteners capable of developing a restraining force commensurate with the strength of the accessory to be mounted and suited for use with the supporting construction. Provide tamperproof design exposed fasteners with finish to match the accessory. Provide fasteners proposed for use for each type of wall construction and mounting.

2.1.2 Finishes

Except where noted otherwise, provide the following finishes on metal:

Metal	Finish
Stainless steel	No. 4 satin finish

2.1.3 Item A5083 Dispenser, Paper Towel, Surface Mounted

Recess mounted paper towel dispenser. Unit constructed of heavy gauge stainless steel with satin finish, all welded construction, have full length piano hinge and tumbler lock. Unit dispenses 300 C-fold or 400 multifold paper towels and be self-feeding until supply is depleted. Towel dispensing slot is snag-free. Unit is ADA compliant.

Approximate size: 12 inches wide by 17 inches high by 4 inches deep.

2.1.4 Item A5109 Grab Bar, 1-1/4 Inch Diameter, SS, 2 Wall, W/C Accessible

Grab bar of 1-1/4 inch diameter satin finish stainless steel with peened gripping surface for use in toilet stall/room. Snap-on flange covers for concealed mounting are stainless steel and equipped with two screw holes for attachment to wall. Grab bars designed to meet and exceed ADA requirements for structural strength. Grab bars designed to withstand loads of 900 pounds when properly installed. Clearance from wall to grab bar is 1-1/2 inches to meet ADA and ANSI codes.

2.1.5 Item A5135 Shelf, Utility W/ Mop/Broom Holders, SS, Surf Mounted

Surface mounted mop/broom holder with shelf made of 18 gauge stainless steel with all exposed surfaces in satin finish. Unit has shelf 8 inches deep with shelf support brackets of satin finish stainless steel welded to

mounting base, and a minimum of 3 hooks/3 holders. Mop holders have spring-loaded rubber cams and hold mop or broom handle with a diameter between 5/8 inch and 1 inch.

Approximate size: 36 inches wide by 8 inches deep.

2.1.6 Item A5145 Hook, Garment, Double, SS, Surface Mounted

Surface mounted double garment hook made of stainless steel with satin finish. For use on door back or wall. Hook comes with concealed mounting bracket secured to concealed wall plate. Mounting hardware included. Flange size is approximately 2 inches by 2 inches.

2.1.7 Item A5195 Dispenser, Toilet Tissue, SS, 1-Roll, Surface Mounted

Concealed surface mounted single roll toilet tissue dispenser of satin finish stainless steel. Spindle to be free-spinning for non-controlled delivery, chrome-plated high impact resistant plastic and equipped with heavy-duty internal spring. Unit accommodates standard core toilet paper roll up to 5-1/2 inches diameter. Mounting hardware included.

Approximate size: 7-3/4 inches wide by 2 inches high by 4 inches deep.

PART 3 EXECUTION

3.1 INSTALLATION

Do not install items that show visual evidence of biological growth. Provide the same finish for the surfaces of fastening devices exposed after installation as the attached accessory. Provide oval exposed screw heads. Install accessories at the location and height indicated. Protect exposed surfaces of accessories with strippable plastic or by other means until the installation is accepted. Provide backing in the wall for the grab bars. After acceptance of accessories, remove and dispose of strippable plastic protection. Coordinate accessory manufacturer's mounting details with other trades as their work progresses. Use sealants for brackets, plates, anchoring devices and similar items in showers (a silicone sealantsealant specified in Section 07 92 00 JOINT SEALANTS) as they are set to provide a watertight installation. After installation, thoroughly clean exposed surfaces and restore damaged work to its original condition or replace with new work.

3.1.1 Recessed Accessories

Fasten accessories with wood screws to studs, blocking or rough frame in wood construction. Set anchors in mortar in masonry construction. Fasten to metal studs or framing with sheet metal screws in metal construction.

3.1.2 Surface Mounted Accessories

Mount on concealed backplates, unless specified otherwise. Conceal fasteners on accessories without backplates. Install accessories with corrosion-resistant fasteners as required by the construction. Install backplates in the same manner, or provide with lugs or anchors set in mortar, as required by the construction. Fasten accessories mounted on gypsum board and plaster walls without solid backing into the metal or wood studs, or to backplates secured to metal studs.

3.2 CLEANING

Clean material in accordance with manufacturer's recommendations. Do not use alkaline or abrasive agents. Take precautions to avoid scratching or marring exposed surfaces.

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SECTION 10 44 16

FIRE EXTINGUISHERS
11/19

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Accessories

Wall Brackets; G, RO

SD-03 Product Data

Accessories

Wall Brackets

Replacement Parts List

1.2 DELIVERY, STORAGE, AND HANDLING

Protect materials from weather, soil, and damage during delivery, storage, and construction.

Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material.

PART 2 PRODUCTS

Submit fabrication drawings consisting of fabrication and assembly details performed in the factory and product data for the following items: Accessories and Wall Brackets.

2.1 SYSTEM DESCRIPTION

2.1.1 Material

Provide enameled steel extinguisher shell.

2.1.2 Size

10 pounds extinguishers.

2.1.3 Accessories

Forged brass valve

Safety release

Pressure gage

2.2 EQUIPMENT

2.2.1 Wall Brackets

Provide wall-hook fire extinguisher wall brackets.

Provide wall bracket and accessories as approved.

2.2.1.1 Identification

Provide lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by the drawings.

Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

Orientation: Vertical.

PART 3 EXECUTION

3.1 INSTALLATION

Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

Comply with the manufacturer's recommendations for all installations.

3.2 PROTECTION

3.2.1 Repairing

Remove and replace damaged and unacceptable portions of completed work with new work at no additional cost to the Government.

Submit replacement parts list indicating specified items replacement part, replacement cost, and name, address and contact for replacement parts distributor.

3.2.2 Cleaning

Clean all surfaces of the work, and adjacent surfaces which are soiled as a result of the work. Remove from the site all construction equipment, tools, surplus materials and rubbish resulting from the work.

-- End of Section --

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DIVISION 11 - EQUIPMENT

SECTION 11 11 37

ELECTRIC VEHICLE SUPPLY EQUIPMENT

11/18

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SECTION 11 11 37

ELECTRIC VEHICLE SUPPLY EQUIPMENT
11/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2023) National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

UL SOLUTIONS (UL)

UL 62	(2018) UL Standard for Safety Flexible Cords and Cables
UL 2202	(2012; Reprint Feb 2018) UL Standard for Safety Electric Vehicle (EV) Charging System Equipment
UL 2231-1	(2012; Reprint Aug 2016) UL Standard for Safety Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements
UL 2231-2	(2012; Reprint Aug 2016) UL Standard for Safety Personnel Protection Systems for Electrical Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems
UL 2251	(2017) UL Standard for Safety Plugs, Receptacles and Couplers for Electric Vehicles
UL 2594	(2016) UL Standard for Safety Electric Vehicle Supply Equipment

1.2 DEFINITIONS

1.2.1 ELECTRIC VEHICLE SUPPLY EQUIPMENT

Electric Vehicle Supply Equipment (EVSE), also referred to as "charging stations," encompasses the conductors, including the ungrounded, grounded, and equipment grounding conductors and the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or

apparatus installed specifically for the purpose of delivering energy from the premises wiring to the electric vehicle (EV). There are three types of EVSE:

a. Level 1 - Refers to a freestanding or wall mounted charging device that delivers a 110/120V charge, replenishing an EV battery at a rate of 4 to 6 miles of range per hour of charging time. Charging an EV at Level 1 typically takes between 7 and 20 hours depending on the size of the vehicle's battery.

b. Level 2 - Refers to a freestanding or wall mounted charging device capable of being networked that delivers a 208/240V charge, replenishing an EV battery at a rate of 10 to 20 miles of range per hour of charging time. Charging an EV at Level 1 typically takes between 2 and 5 hours depending on the size of the vehicle's battery.

c. Direct Current (DC) Fast Charging, a freestanding or wall mounted device capable of being networked that is designed to charge vehicles more quickly than Level 1 or Level 2 with an electrical output ranging between 40 kW - 120 kW delivering a charge of up to 480V. DC Fast Charging can typically replenish an EV battery at a rate of 50 to 90 miles of range per 30 minutes of charging time.

1.2.2 Certified Installers

Installers must be certified by EVSE manufacturer or a recognized certified training agency.

1.3 RELATED REQUIREMENTS

Materials not considered to be Electric Vehicle Supply Equipment or accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION and Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section with the additions and modifications specified herein.

1.4 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

In addition, submit in accordance with paragraph COORDINATED SUBMITTAL REVIEWS herein.

SD-02 Shop Drawings

Cords; G, DO

Level 2 Wall Mounted EVSE; G, DO

SD-03 Product Data

Cords; G, DO

Level 2 Wall Mounted EVSE; G, DO

SD-07 Certificates

Qualifications

Certified Installers

SD-08 Manufacturer's Instructions

Cords; G, DO

Level 2 Wall Mounted EVSE; G, DO

SD-09 Manufacturer's Field Reports

Testing of Electric Vehicle Supply Equipment

SD-10 Operation and Maintenance Data

Electric Vehicle Supply Equipment; G, RO

SD-11 Closeout Submittals

Warranty; G, RO

Record Documentation; G, RO

1.5 MAINTENANCE MATERIAL SUBMITTALS

Provide a list of manufacturer recommended maintenance items required for EVSE Operation.

1.5.1 Operation and Maintenance Manuals

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit two manuals and electronic file at least 2 weeks prior to field training.

1.5.2 Spare Parts

Provide one spare cord and connector assembly.

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under comparable circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.2.1 Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.2.2 Material and Equipment Manufacturing Date

Provide products manufactured within 2 years prior to date of delivery to site. As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment, and devices.

1.6.2.3 EVSE Installers

Submit documentation certifying that pertinent personnel are qualified for EVSE installation. The documentation must include installation experience on two projects of comparable size and scope of work.

1.7 WARRANTY

Provide equipment items supported by service organizations that are convenient to the equipment installation in order to render satisfactory service to the equipment within 24 hours of notification during the warranty period of the contract.

Provide warranty for Materials and Workmanship of EVSE: Two years.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Provide products and materials not considered to be ELECTRIC VEHICLE SUPPLY EQUIPMENT and related accessories for power requirements as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.2 ELECTRIC VEHICLE SUPPLY EQUIPMENT

2.2.1 System Description

Electric Vehicle Supply Equipment capable of charging one vehicle at Level 2.

2.2.2 Level 2 EVSE

2.2.2.1 Level 2 Wall Mounted EVSE

UL 2202, UL 2251, UL 2231-1, UL 2231-2, UL 2594. Type 2, SAE J1772 connector, Direct Wired, 208 volt, with a minimum input 30 amps, output 30 amps, 7.2 kW.

2.2.3 Cords

UL 62.

a. 14 feet, minimum, UL rated charging cords with integral retractable cord management mechanism or separate cord management.

2.3 CONNECTOR HOLSTER DOCK

Provide connector holster dock to store charger plugs when not in use. Holster construction consist of high strength injection molded plastic with temperature ratings of minus 30 deg C to 50 deg C. Provide holster to match EV plug.

2.4 ACCESSORIES

a. Back-lit touch button interface keypad with audio feedback. LCD must display READY TO CHARGE, CHARGING, CHARGE COMPLETE, PAUSE-WAITING TO CHARGE AND FAULT.

2.5 MANUFACTURER'S NAMEPLATES

Each item of equipment shall have a nameplate bearing, as a minimum, the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. Include additional information as applicable to fully identify the equipment. Nameplates shall be made of noncorrosive metal.

2.6 PAVEMENT MARKINGS

Provide pavement markings for the vehicle charging parking spots to indicate the restrictions for electrical vehicle parking.

2.7 ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE) SIGNAGE

Provide signage Electric Vehicle Supply Equipment per MUTCD and Base standards.

2.8 WHEEL STOPS AND BOLLARDS

Provide bollards to provide protection for Electric Vehicle Supply Equipment.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

a. The EVSE installer must be certified by the manufacturer or a recognized training facility to perform the installation.

b. Provide chargers per manufacturer instructions and recommendations. EVSE must be programmed and configured by a certified installer.

3.2 GROUNDING

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 25 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.3 FIELD APPLIED PAINTING

Where field applied painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.5.1 Exterior Location

Mount on concrete slab, unless otherwise indicated. The slab shall be at least 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. Top of concrete slab shall be approximately 4 inches above the finished grade. Edges above grade shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter. Cut off and bush conduits 3 inches above slab surface.

3.6 OPERATION AND MAINTENANCE

3.6.1 Operation and Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of 4 hours for level 2 charging of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training Materials and schedule concurrently with the Operation and Maintenance Manuals and at least 30 days prior to conducting the training course.

3.7 RECORD DOCUMENTATION

Provide drawings indicating construction provided for this project. Provide electronic files and hard copies on 11 inch by 17 inch paper.

3.8 FIELD QUALITY CONTROL

3.8.1 Testing of Electric Vehicle Supply Equipment

Provide testing of Electric Vehicle Supply Equipment with test equipment per current standards and manufacturers recommendations. Provide data submittal indicating time of charge and kW level used.

3.8.2 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests. Submit reports, including acceptance criteria.

3.8.2.1 EVSE

a. Visual and mechanical inspection.

   (1) Compare equipment nameplate data with specifications and approved shop drawings.

   (2) Inspect physical and mechanical condition. Check for damage.

   (3) Inspect anchorage, alignment, and grounding.

   (4) Perform specific inspections and mechanical tests as recommended by manufacturer.

b. Electrical Tests

   (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

   (2) Verify voltage levels.

   (3) Check ground fault circuit interrupt.

   (4) Check pilot signal detection and verification.

(5) Verify current limit.

(6) Verify operation of alarms.

(7) Verify EVSE Electronic Data Interface.

Values of test shall be within limits of manufacturer's recommendations.

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DIVISION 12 - FURNISHINGS

SECTION 12 21 00

WINDOW BLINDS

08/17, CHG 2: 11/18

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-- End of Section Table of Contents --

SECTION 12 21 00

WINDOW BLINDS
08/17, CHG 2: 11/18

PART 1 GENERAL

1.1 SUMMARY

Provide window treatment, conforming to NFPA 701, complete with necessary brackets, fittings, and hardware. Provide each window treatment type as a complete unit in accordance with paragraph WINDOW TREATMENT PLACEMENT SCHEDULE. Mount and operate equipment in accordance with manufacturer's instructions. Completely cover windows to receive a treatment.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G"classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES

SD-02 Shop Drawings

Installation

SD-03 Product Data

Window Blinds; G, DO

SD-04 Samples

Window Blinds; G, DO

SD-06 Test Reports

Window Blinds

SD-07 Certificates

SD-08 Manufacturer's Instructions

Window Blinds; G, RO

SD-10 Operation and Maintenance Data

Window Blinds; G, RO

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver components to the jobsite in the manufacturer's original packaging with the brand or company name, item identification, and project reference clearly marked. Store components in a dry location that is adequately ventilated and free from dust, water, or other contaminants and has easy access for inspection and handling. Store materials flat in a clean dry area with temperature maintained above 50 degrees F. Do not open containers until needed for installation unless verification inspection is required.

1.5 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 WINDOW BLINDS

Provide each blind, including hardware, accessory items, mounting brackets and fastenings, as a complete unit produced by one manufacturer. Unless otherwise indicated, all parts will be the same color and will match the color of the blind slat. Treat steel features for corrosion resistance. Submit product data and samples of each type and color of window treatment. Provide slat samples 6 inch in length for each color.

2.1.1 Horizontal Blinds

Provide horizontal blinds with 1 inch slats. Blind units must be capable of nominally 180 degree partial tilting operation and full-height raising. Blinds must be inside mount. Tapes for 1 inch slats must be braided polyester or nylon.

2.1.1.1 Head Channel and Slats

Provide head channel made of steel or aluminum with corrosion-resistant finish nominal 0.024 inch for 1 inch slats. Provide slats of aluminum, not less than 0.008 inch thick, and of sufficient strength to prevent sag or bow in the finished blind. Provide a sufficient amount of slats to assure proper control, uniform spacing, and adequate overlap. Enclose all hardware in the headrail.

2.1.1.2 Controls

A transparent tilting wand will be provided to tilt the slats, it will hang vertically by its own weight, and will swivel for easy operation. Provide a tilter control of enclosed construction. Provide moving parts and mechanical drive made of compatible materials which do not require lubrication during normal expected life. The tilter will tilt the slats to any desired angle and hold them at that angle so that any vibration or movement of ladders and slats will not drive the tilter and change the angle of slats. Include a mechanism to prevent over tightening. Provide a wand of sufficient length to reach to within 5 feet of the floor.

2.1.1.3 Intermediate Brackets

Provide intermediate brackets for installation, as recommended by the manufacturer, of blinds over 48 inch wide.

2.1.1.4 Bottom Rail

Provide bottom rail made of corrosion-resistant steel with factory applied finish. Provide closed oval shaped bottom rail with double-lock seam for maximum strength. Bottom rail and end caps to match slats in color.

2.1.1.5 Braided Ladders

Provide braided ladders of 100 percent polyester yarn, color to match the slat color. Space ladders 15.2 slats per foot of drop in order to provide a uniform overlap of the slats in a closed position.

2.1.1.6 Hold-Down Brackets

Provide universal type hold-down brackets for sill or jamb mount where indicated on placement list.

2.1.2 Light Control and Privacy Blinds

In addition to requirements for horizontal blinds, provide each unit with a feature that offers hidden slat holes for maximum light control and privacy.

2.2 COLOR

Provide color, pattern and texture in accordance with Section 09 06 00 SCHEDULES FOR FINISHES Color listed is not intended to limit the selection of equal colors from other manufacturers.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 WINDOW TREATMENT PLACEMENT SCHEDULE

All exterior windows include horizontal blinds.

3.3 INSTALLATION

Do not install building construction materials that show visual evidence of biological growth.

Submit drawings showing fabrication and Installation details. Show layout and locations of track, direction of draw, mounting heights, and details. Provide Manufacturer's Instructions and Operation and Maintenance Data. Perform installation of window blinds in accordance with the approved detail drawings and manufacturer's installation instructions. Install units level, plumb, secure, and at proper height and location relative to

window units. Provide and install supplementary or miscellaneous items in total, including clips, brackets, or anchorages incidental to or necessary for a sound, secure, and complete installation. Do not start installation until completion of room painting and finishing operations.

3.4 CLEAN-UP

Upon completion of the installation, inspect window treatments for soiling, damage or blemishes; and adjust them for form and appearance and proper operating condition. Repair or replace damaged units as directed by the Contracting Officer. Isolate metal parts from direct contact with concrete, mortar, or dissimilar metals. Ensure blinds installed in recessed pockets can be removable without disturbing the pocket. The entire blind, when retracted, must be contained behind the pocket. For blinds installed outside the jambs and mullions, overlap each jamb and mullion 0.75 inch or more when the jamb and mullion sizes permit. Include all hardware, brackets, anchors, fasteners, and accessories necessary for a complete, finished installation.

-- End of Section --

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DIVISION 13 - SPECIAL CONSTRUCTION

SECTION 13 48 73

SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT

05/22

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SECTION 13 48 73

SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT
05/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 355.2	(2007) Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary
ACI 355.4	(2011) Qualification of Post-Installed Adhesive Anchors in Concrete (ACI 355.4) and Commentary

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and

	Shapes
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A603	(2019) Standard Specification for Zinc-Coated Steel Structural Wire Rope
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ICC EVALUATION SERVICE, INC. (ICC-ES)	
ICC ES AC156	(2012) Acceptable Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components
ICC-ES AC23	(2012; R 2016) Acceptance Criteria for Sprayed Fire-resistant Materials (SFRMs), Intumescent Fire-resistant Coatings and Mastic Fire-resistant Coatings Used to Protect Structural Steel Members
INTERNATIONAL CODE COUNCIL (ICC)	
ICC IBC	(2024) International Building Code
METAL FRAMING MANUFACTURERS ASSOCIATION (MFMA)	
MFMA-4	(2004) Metal Framing Standards Publication
U.S. DEPARTMENT OF DEFENSE (DOD)	
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-301-02	(2023) Design of Risk Category V Structures, National Strategic Military Assets
UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings
VIBRATION ISOLATION AND SEISMIC CONTROL MANUFACTURERS ASSOCIATION (VISCMA)	
VISCMA 412	(2014) Installing Seismic Restraints for Mechanical Equipment

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Apply the requirements for seismic protection measures, described in this section and on the drawings, of the miscellaneous equipment and systems

listed below, in accordance with UFC 3-301-01 and additional data furnished by the Contracting Officer. Provide seismic protection measures in addition to any other requirements called for in other sections of these specifications. Where there is a conflict between the specifications and the drawings, the specifications will take precedence. Accomplish resistance to lateral forces induced by earthquakes without consideration of friction resulting from gravity loads
.

1.2.2 Miscellaneous Equipment and Systems

Provide bracing and attachment for the following miscellaneous equipment and components developed by the Contractor in accordance with the requirements of this specification:

M ission Critical Level 2 (MC-2) Equipment/Components in Risk Category V designed in accordance with UFC 3-301-02:

- Storage cabinets
- Ornamentations
- Storage Racks
- Signs and Billboards
- Shelving
- Furnishings
- Partitions
- Stacks
- Pole or frame supported equipment
- Storage tanks for water and oil

1.2.3 Contractor Designed Bracing

Submit copies of the design calculations with the drawings. Calculations must be approved, certified, stamped and signed by a registered Professional Structural Engineer. Calculations must verify the capability of structural members to which bracing is attached for carrying the load from the brace. Design the bracing in accordance with UFC 3-301-01, UFC 4-010-01 and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes must be accomplished without consideration of friction resulting from gravity loads. UFC 3-301-01 uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas must be required. Loadings determined using UFC 3-301-01 are based on strength design; therefore, AISC 325 Specifications must be used for the design. The bracing for the equipment designated in paragraph 1.2.2 must be developed by the Contractor. Provide documentation of an independent design review for mission critical (MC) equipment bracing design. Documentation must be signed by the independent reviewer who must also be a registered structural engineer.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Bracing; G, DO

Resilient Vibration Isolation Devices;

Equipment Requirements;

SD-03 Product Data

Bracing;

Equipment Requirements;

Anchor Bolts;

Vibration Isolators; G, DO

Snubbers;

SD-05 Design Data

Design Calculations; G, DO

SD-06 Test Reports

Anchor Bolts;

SD-07 Certificates

ICC ES AC156 Shake Table Test; G, DO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

Submit detail drawings of bracing along with calculations, catalog cuts, templates, and erection and installation details, as appropriate, for the items listed in Paragraph 1.2.2. Indicate thickness, type, grade, class of metal, and dimensions; and show construction details, reinforcement, anchorage, and installation with relation to the building construction. Provide calculations and drawings that are stamped by a registered structural engineer, and that verify the capability of structural members to which bracing is attached for carrying the load from the brace. Design must be based on actual equipment and system layout. Design must include calculated dead loads, static seismic loads and capacity of materials utilized for the connection of the equipment or system to the structure. Analysis must detail anchoring methods.

Include drawing for Mission Critical Equipment and Designated Seismic System Equipment indicating the equipment location in the facility sufficient to be used for the installation. Equipment must be rigidly or

flexibly mounted as indicated in the specifications and/or drawings depending on vibration isolation requirements as follows below. Roof mounted equipment both vibration isolated and nonisolated, must have support members designed and anchored to building structural steel or concrete as required for seismic restraint and wind loads.

2.1.1 Rigidly (Base and Suspended) Mounted Equipment

Equipment furnished under this contract must be rigidly mounted using cast-in-place anchor bolts to anchor them or post-installed anchors that are qualified for earthquake loading in accordance with ACI 355.2 and ACI 355.4. Anchor bolts must conform to ASTM F1554-07ae1. For any rigid equipment which is rigidly anchored, provide flexible joints for piping, electrical conduit, etc., that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions. Suspended equipment bracing attachments should be located just above the center of gravity to minimize swinging. Mission critical base mounted and suspended equipment for Risk Category (RC) V, and Designated Seismic Systems (DSS) RC IV buildings assigned to Seismic Design Category Coefficient (SDC) C, D, E, or F and Risk Category IV components needed for continued operation after an earthquake must have two nuts provided on each anchor bolt.

2.1.2 Nonrigid or Flexibly-Mounted Equipment

Select vibration isolation devices so that the maximum movement of equipment from the static deflection point is 1/4 inch. Equipment flexibly mounted on vibration isolators must have a bumper restraint or snubber in each horizontal direction and vertical restraints must be provided where require to resist overturning. Isolator housing and restraints must be constructed of ductile materials. A viscoelastic pad or similar material of appropriate thickness must be used between the bumper and components to limit the impact load. Restraints must be designed to resist the calculated horizontal lateral and vertical forces.

Spring vibration isolators must be seismically rated, restrained isolators for equipment subject to load variations and large external forces. The seismically rated housing must be sized to meet or exceed the force requirements applicable to the project and meet the required isolation criteria. Spring vibration isolator manufacturer's will be a member of VISCMA. Design force, Fp, must be doubled for vibration isolators with an air gap greater than 0.25 inches as specified in ASCE 7-16, Chapter 13.

2.2 BOLTS AND NUTS

Hex head bolts, and heavy hexagon nuts must be ASTM A325 or ASTM A490 bolts and ASTM A563 nuts. Provide bolts and nuts galvanized in accordance with ASTM A153/A153M when used underground or exposed to weather.

2.3 SWAY BRACING

Material used for members listed in this section and on the drawings, must be structural steel conforming with the following:

a. Plates, rods, and rolled shapes, ASTM A36/A36M.

b. Wire rope, ASTM A603.

c. Tubes, ASTM A500/A500M, Grade B.

d. Pipes, ASTM A53/A53M, Grade B.

e. Angles, ASTM A36/A36M.

f. Channels (Struts) with in-turned lips and associated hardware for fastening to channels at random points conforming to MFMA-4.

PART 3 EXECUTION

3.1 BRACING

Provide bracing conforming to the arrangements shown. Install cables at a 45-degree slope. Where interference is present, the slope may be minimum of 30 degrees or a maximum of 60 degrees per VISCMA 412.

3.2 BUILDING DRIFT

Do not attach sway braces for equipment to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided. Bracing must be capable of accommodating building drift due to seismic displacements.

3.3 ANCHOR BOLTS

3.3.1 General

Submit copies of test results to verify the adequacy of the specific anchor and application, as specified.

Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices allowing adequate edge distance and embedment depth for restraint anchor bolts. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Install neoprene grommet washers or till the gap with epoxy on equipment anchor bolts where clearance between anchor and equipment support hole exceeds 0.125 inches.

3.3.2 Cast-In-Place

Use templates to locate cast-in-place bolts accurately and securely in formwork. Provide anchor bolts with an embedded straight length equal to at least 12 times nominal diameter of the bolt. Anchor bolts that exceed the normal depth of equipment foundation piers or pads must either extend into concrete floor or the foundation or be increased in depth to accommodate bolt lengths. Use templates to locate cast-in-place bolts accurately and securely in formwork.

3.3.3 Drilled-In Anchor Bolts

Drill holes with rotary impact hammer drills. Drill bits must be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the drawings, all holes must be drilled perpendicular to the concrete surface. Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging

existing reinforcing or embedded items. Notify the COR if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines. Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Perform anchor installation in accordance with manufacturer instructions. For Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors, protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10 percent of the specified torque, 100 percent of the specified torque must be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor must be removed and replaced unless otherwise directed by the Engineer.

For Cartridge Injection Adhesive Anchors where approved for seismic application, clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive must be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed. For Capsule Anchors where approved for seismic application, perform drilling and setting operations in accordance with manufacturer instructions. Clean all holes to remove loose material and drilling dust prior to installation of adhesive. Remove water from drilled holes in such a manner as to achieve a surface dry condition. Capsule anchors must be installed with equipment conforming to manufacturer recommendations. Do not disturb or load anchors before manufacturer specified cure time has elapsed. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

3.3.4 Anchor Bolt Testing

Test in place expansion and chemically bonded anchors not more than 24 hours after installation of the anchor, conducted by an independent testing agency; testing must be performed on random anchor bolts as described below.

3.3.4.1 Torque Wrench Testing

Perform torque wrench testing on not less than 50 percent of the total installed expansion anchors and at least one anchor for every piece of equipment containing more than two anchors. The test torque must equal the minimum required installation torque as required by the bolt manufacturer. Calibrate torque wrenches at the beginning of each day the torque tests are performed. Recalibrate torque wrenches for each bolt diameter whenever tests are run on bolts of various diameters. Apply torque between 20 and 100 percent of wrench capacity. Reach the test torque within one half turn of the nut, except for 3/8 inch sleeve anchors which must reach their torque by one quarter turn of the nut. If any anchor fails the test, test similar anchors not previously tested until 20 consecutive anchors pass. Failed anchors must be retightened and retested

to the specified torque; if the anchor still fails the test it must be replaced.

3.3.4.2 Pullout Testing

Test expansion and chemically bonded anchors by applying a pullout load using a hydraulic ram attached to the anchor bolt. Testing must be done in accordance with ASTM E488/E488M or ICC-ES AC23. At least 5 percent of the anchors, but not less than 3 per day must be tested. Apply the load to the anchor without removing the nut; when that is not possible, the nut must be removed and a threaded coupler must be installed of the same tightness as the original nut. Check the test setup to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures. The support for the testing apparatus must be at least 1.5 times the embedment length away from the bolt being tested. Load each tested anchor to 1 times the design tension value for the anchor. The anchor must have no observable movement at the test load. If any anchor fails the test, similar anchors not previously tested must be tested until 10 consecutive anchors pass. Failed anchors must be retightened and retested to the specified load; if the anchor still fails the test it must be replaced.

3.4 RESILIENT VIBRATION ISOLATION DEVICES

Where the need for these devices is determined, based on the magnitude of the design seismic forces, select anchor bolts for vibration isolation devices and/or snubbers for equipment base and foundations that follow the same procedure as in paragraph ANCHOR BOLTS, except use an equipment weight equal to five times the actual equipment weight.

3.4.1 Spring-Type Vibration Devices

Select vibration isolation devices so that the maximum movement of equipment from the static deflection point is 1/2 inch. Equipment flexibly mounted on vibration isolators must have a bumper restraint or snubber in each horizontal direction and vertical restraints must be provided where required to resist overturning. Isolator housing and restraints must be constructed of ductile materials. A viscoelastic pad or similar material of appropriate thickness must be used between the bumper and components to limit the impact load. Restraints must be designed to resist the calculated horizontal lateral and vertical forces.

Spring vibration isolators must be seismically rated, restrained isolators for equipment subject to load variations and large external forces. The seismically rated housing must be sized to meet or exceed the force requirements applicable to the project and meet the required isolation criteria. Spring vibration isolator manufacturers will be a member of VISCMA.

3.4.2 Multidirectional Seismic Snubbers

Install multidirectional seismic snubbers employing elastomeric pads on floor- or slab-mounted equipment. Use snubbers that provide 1/4 inch free vertical and horizontal movement from the static deflection point. Provide snubber medium consisting of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

3.5 EQUIPMENT SWAY BRACING

3.5.1 Suspended Equipment

Provide equipment sway bracing for items supported from floor, overhead floor or roof structural systems. Provide braces that consist of angles, rods, wire rope, bars, channels (struts) or pipes arranged as shown in bracing submittals and secured at both ends with not less than 1/2 inch bolts. Provide sufficient braces for equipment to resist a horizontal force as specified in UFC 3-301-01 without exceeding safe working stress of bracing components. Provide, for approval, specific force calculations in accordance with UFC 3-301-01 for the equipment in the project. Submit details of equipment bracing for acceptance. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight of equipment when hangers are inclined at a 45-degree angle.

3.5.2 Floor or Pad Mounted Equipment

3.5.2.1 Shear Resistance

Bolt to the floor, floor mounted equipment. Provide the number and installation of bolts to resist shear forces in accordance with paragraph ANCHOR BOLTS.

3.5.2.2 Overturning Resistance

Use the ratio of the overturning moment from seismic forces to the resisting moment due to gravity loads to determine if overturning forces need to be considered in the sizing of anchor bolts. Provide calculations to verify the adequacy of the anchor bolts for combined shear and overturning.

3.6 SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT

Equipment and components designated as MC-1 (Mission Critical Level 1) Designated Seismic Systems required to remain operational after an earthquake will be seismic qualified by shake table testing conforming to ICC ES AC156 Shake Table Test procedures. The manufacturer is to provide a certification by a fully qualified testing agency for the specific equipment and/or components. Prequalified certifications are acceptable unless noted otherwise. Seismic component qualification documentation for each piece of equipment must contain the information required in UFC 3-301-02, Section 2-17.2.5 Component Qualification Documentation.

Miscellaneous components that are required to be certified must bear permanent marking or nameplates constructed of a durable heat and water resistant material. Nameplates must be mechanically attached to such nonstructural components and placed on each component for clear identification. The nameplate must not be less than 5 inches x 7 inches with red letters 1 inch in height on a white background stating "Certified Equipment." The following statement must be on the nameplate: "This equipment/component is certified. No modifications are allowed unless authorized in advance and documented in the Equipment Certification Documentation file." The nameplate must also contain the component identification number in accordance with the drawings/specifications and

the O&M manuals.

3.7 SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS AND EQUIPMENT

Perform special inspections for seismic-resisting systems, equipment and components for structures assigned to Risk Category V; designated seismic systems and equipment per ICC IBC 1705.12.4; and storage racks per ICC IBC 1705.12.7. Periodic special inspections will be conducted on miscellaneous equipment as required by Section 1705.12 of the International Building Code and paragraph 2-2.4.3 of UFC 3-301-01. Provide a Statement of Special Inspections and Final Report in accordance with paragraph 2-2.4.3 of UFC 3-301-01.

-- End of Section --

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WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Use the most recent editons of the references below if there isn't a year referenced.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1015	(2021) Performance Requirements for Double Check Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA M14	(2024) Manual: Recommended Practice for Backflow Prevention and Cross-Connection Control

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalg

INTELLIGENCE COMMUNITY STANDARD (ICS)

ICS 705-1	(2010) Physical and Technical Security Standard for Sensitive Compartmented Information Facilities

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	Standard for the Installation of Sprinkler Systems
NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 291	Recommended Practice for Fire Flow Testing and Marking of Hydrants
NFPA 1963	(2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler

System Layout

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-600-01	(2016; with Change 6, 2021) Fire Protection Engineering for Facilities
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 199	(2020) UL Standard for Safety Automatic Sprinklers for Fire-Protection Service
UL 262	(2004; Reprint Jul 2023) Gate Valves for Fire-Protection Service
UL 312	(2022) UL Standard for Safety Check Valves for Fire-Protection Service
UL 405	(2013; Bul. 2020) UL Standard for Safety Fire Department Connection Devices
UL 668	(2004; Reprint Oct 2021) UL Standard for Safety Hose Valves for Fire-Protection Service
UL 789	(2004; Reprint May 2024) UL Standard for Safety Indicator Posts for Fire-Protection Service
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 SYSTEM DESCRIPTION

Provide wet pipe sprinkler system in areas indicated on the drawings. Except as modified herein, the system must meet the requirements of UFC 3-600-01 and installed per NFPA 13. Pipe sizes which are not indicated on the Contract drawings must be determined by hydraulic calculations.

1.2.1 Hydraulic Design

1.2.1.1 Basis for Calculations

A waterflow test was performed on July 21, 2023, at Buckley SFB, Colorado, and resulted in a static pressure of 77.5 psig with a residual pressure of 30 psig while flowing 1,400 gpm. The water flow test data is only for reference and is not to be used for system design. Perform a new fire hydrant flow test prior to shop drawing submittal in accordance with NFPA 291. Results must include hydrant elevations relative to the building and hydrant number/identifiers for the tested hydrants, including which were flowed, which had a gauge. This information must be presented in a tabular form if multiple hydrants were flowed. The results must be included with the hydraulic calculations. Hydraulic calculations must be based on the new flow test. Hydraulic calculations must be based upon the Hazen-Williams formula with a "C" value noted in NFPA 13 for piping, and 100for existing underground piping. Hydraulic calculations must be based

on operation of the fire pump(s) provided in Section 21 30 00 FIRE PUMPS. The minimum residual pressure in a service lateral (lead-in) at the 150 percent of the fire pump rated flow must be 20 psi at the suction side of the fire pump.

1.2.1.2 Hydraulic Calculations

a. Water supply curves and system requirements must be plotted on semi-logarithmic graph (N^1.85) paper so as to present a summary of the complete hydraulic calculation.

b. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, minimum discharge pressures and minimum flows. Elevations of hydraulic reference points (nodes) must be indicated.

c. Documentation must identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe.

d. Where the sprinkler system is supplied by interconnected risers, the sprinkler system must be hydraulically calculated using the hydraulically most demanding single riser. The calculations must not assume the simultaneous use of more than one riser.

e. All calculations must include the backflow preventer manufacturer's stated friction loss at the design flow or 8 psi for double check backflow preventer, whichever is greater.

f. All calculations must be performed back to the actual location of the flow test, taking into account the direction of flow in the service main at the test location.

g. For gridded systems, calculations must show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. A flow diagram indicating the quantity and direction of flows must be included.

1.2.1.3 Design Criteria

Hydraulically design the system to discharge a minimum density as indicated on the drawings. Hydraulic calculations must be in accordance with the Area/Density Method of UFC 3-600-01, and NFPA 13. Add an allowance for exterior hose streams of 250 gpm gpm to the sprinkler system demand at the fire hydrant shown on the drawings closest to the point where the water service enters the building

1.2.2 Sprinkler Coverage

Sprinklers must be uniformly spaced on branch lines. Provide coverage throughout 100 percent of the building. This includes, but is not limited to, telephone rooms, electrical equipment rooms (regardless of the fire resistance rating of the enclosure), boiler rooms, switchgear rooms, transformer rooms, attached electrical vaults and other electrical and mechanical spaces. Coverage per sprinkler must be in accordance with NFPA 13. Provide sprinklers below all obstructions in accordance with NFPA 13.

1.2.3 Qualified Fire Protection Engineer (QFPE)

An individual who is a licensed professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Working (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Provide a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting all outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government and final Government functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

The submittal requirement for the Qualified Fire Protection Engineer (QFPE) is found in Section 28 31 70 and applies to all Sections in which the requirement for Qualified Fire Protection Engineer (QFPE) is present.

1.3 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Partial submittals and submittals not fully complying with NFPA 13 and this specification section must be returned disapproved without review. SD-02, SD-03 and SD-05 must be submitted simultaneously.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE must be returned disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sprinkler System Designer; G, DO

Sprinkler System Installer; G, DO

SD-02 Shop Drawings

Shop Drawing; G, DO

SD-03 Product Data

Pipe; G, DO

Fittings; G, DO

Valves, including gate, check, butterfly, and globe; G, DO

Relief Valves; G, DO

Sprinklers ; G, DO

Pipe Hangers and Supports ; G, DO

Sprinkler Alarm Switch; G, DO

Valve Supervisory (Tamper) Switch; G, DO

Fire Department Connection; G, DO

Backflow Prevention Assembly; G, DO

Air Vent; G, DO

Hose Valve; G, DO

Seismic Bracing; G, DO

Nameplates; G, RO

SD-05 Design Data

Seismic Bracing; G, DO

Load calculations for sizing of seismic bracing

Hydraulic Calculations; G, DO

SD-06 Test Reports

Test Procedures; G, RO

SD-07 Certificates

Verification of Compliant Installation; G, RO

Request for Government Final Test; G, RO

SD-10 Operation and Maintenance Data

Operating and Maintenance (O&M) Instructions; G, RO

Spare Parts Data; G, RO

SD-11 Closeout Submittals

As-built drawings

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 QUALITY ASSURANCE

1.4.1 Preconstruction Submittals

Within 36 days of contract award but no less than 14 days prior to commencing work on site, the prime Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications will be returned Disapproved Without Review.

1.4.1.1 Shop Drawing

6 copies of the shop drawings, no later than 28 days prior to the start of system installation. Working drawings conforming to the requirements prescribed in NFPA 13 and must be no smaller than ANSI D. Each set of drawings must include the following:

a. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.

b. Floor plans drawn to a scale not less than 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, and other details required to clearly describe the proposed arrangement.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross mains and branch lines to finished floor and roof or ceiling. A detail must show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

d. Longitudinal and transverse building sections showing typical branch line and cross main pipe routing, elevation of each typical sprinkler above finished floor and elevation of "cloud" or false ceilings in relation to the building ceilings.

e. Plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance.

f. Riser layout drawings drawn to a scale of not less than 1/2-inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

g. Details of each type of riser assembly, pipe hanger, sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. The dimension from the edge of vertical piping to the nearest adjacent wall(s) must be indicated on the drawings when vertical piping is located in stairs or other portions of the means of egress.

h. Details of each type of pipe hanger, seismic bracing/restraint and related components.

i. Include fire pump curve with shop drawings and hydraulic calculations.

j. See coordinated submittal requirements regarding this submittal item with respect to impacted submittal content by other trades, most notably alterations and accommodations of footing reinforcement for water entrance with vertical routing through the footings.

1.4.1.2 Product Data

6 copies of annotated catalog data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, options, and other pertinent information, that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

1.4.1.3 Hydraulic Calculations

Calculations must be as outlined in NFPA 13 except that calculations must be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Calculations must include isometric diagram indicating hydraulic nodes and pipe segments. Include fire pump curve with submittal.

1.4.1.4 Operating and Maintenance (O&M) Instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA as supplemented and modified by this specification section.

Provide six manuals and one pdf version on electronic media. The manuals must include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment.

Submit spare parts data for each different item of material and equipment specified. The data must include a complete list of parts and supplies, and a list of parts recommended by the manufacturer to be replaced after 1-year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

1.4.2 Qualifications

1.4.2.1 Sprinkler System Designer

The sprinkler system designer must be certified as a Level III Technician by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.4.2.2 Sprinkler System Installer

The sprinkler system installer must be regularly engaged in the installation of the type and complexity of system specified in the contract documents, and must have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.4.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of an item or equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation are mandatory requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. All pipes must be either capped or plugged until installed.

1.6 EXTRA MATERIALS

Spare sprinklers and wrench(es) must be provided as spare parts in accordance with NFPA 13.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials, equipment, and devices listed for fire protection service when so required by NFPA 13 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for a classification of material. Material and equipment must be standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid.

2.1.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract

number provided on a new name plate permanently affixed to the item or equipment. Nameplates must be etched metal or plastic, permanently attached by screws to control units, panels or adjacent walls.

2.1.3 Identification and Marking

Pipe and fitting markings must include name or identifying symbol of manufacturer and nominal size. Pipe must be marked with ASTM designation. Valves and equipment markings must have name or identifying symbol of manufacturer, specific model number, nominal size, name of device, arrow indicating direction of flow, and position of installation (horizontal or vertical), except if valve can be installed in either position. Markings must be included on the body casting or on an etched or stamped metal nameplate permanently on the valve or cover plate.

2.1.4 Pressure Ratings

Valves, fittings, couplings, alarm switches, and similar devices must be rated for the maximum working pressures that can be experienced in the system, but in no case less than 175 psi.

2.2 UNDERGROUND PIPING COMPONENTS

2.2.1 Pipe

Pipe must comply with NFPA 24. Minimum pipe size is 6 inches. See Civil Plans. Piping more than 5 feet outside the building walls must comply with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING. A continuous section of welded stainless steel fire water service piping from a point outside the building perimeter to a flanged fitting at least 1-foot above the finished floor within the building is acceptable.

2.2.2 Fittings and Gaskets

Fittings must be ductile-iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets must be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile-iron pipe joints must conform to AWWA C111/A21.11.

2.2.3 Gate Valve and Indicator Posts

Installation must comply with NFPA 24. Gate valves for use with indicator post must conform to UL 262. Indicator posts must conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.

2.2.4 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape, 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold block letters continuously and repeatedly over the entire tape length. Warning and identification must read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.3 ABOVEGROUND PIPING COMPONENTS

2.3.1 Steel Piping Components

2.3.1.1 Steel Pipe

Except as modified herein, steel pipe must be black as permitted by NFPA 13 and conform to the applicable provisions of ASTM A53/A53M, ASTM A135/A135M or ASTM A153/A153M.

Steel pipe must be Schedule 40 only. Grooved pipe must be cut-grooved.

2.3.1.2 Fittings

Fittings must be welded, threaded, or grooved-end type. Threaded fittings must be cast-iron conforming to ASME B16.4, malleable-iron conforming to ASME B16.3 or ductile-iron conforming to ASTM A536. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe, steel press fittings and field welded fittings are not permitted. Fittings, mechanical couplings, and rubber gaskets must be supplied by the same manufacturer. Threaded fittings must use Teflon tape or manufacturer's approved joint compound. Saddle tees are not allowed. Reducing couplings are not permitted except as allowed by NFPA 13.

2.3.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings must be designed for not less than 175 psi service and the product of the same manufacturer. Field welded fittings must not be used. Fitting and coupling housing must be malleable-iron conforming to ASTM A47/A47M, Grade 32510; ductile-iron conforming to ASTM A536, Grade 65-45-12. Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 2 inches and larger. Gasket must be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts must be heat-treated steel conforming to ASTM A183 and must be cadmium-plated or zinc-electroplated.

2.3.1.4 Flanges

Flanges must conform to NFPA 13 and ASME B16.1. Gaskets must be non-asbestos compressed material in accordance with ASME B16.21, 1/16-inch thick, and full face or self-centering flat ring type.

2.3.2 Flexible Sprinkler Hose

The use of flexible hose is not permitted.

2.3.3 Pipe Hangers and Supports

Provide galvanized pipe hangers, supports and seismic bracing in accordance with NFPA 13. Design and install seismic protection in accordance with the requirements of NFPA 13 section titled "Protection of Piping Against Damage Where Subject to Earthquakes for Seismic Design Category "F".

2.3.4 Valves

Provide valves of types approved for fire service. Valves must open by counterclockwise rotation.

2.3.4.1 Control Valve

Manually operated sprinkler control/gate valve must be outside stem and yoke (OS&Y) type or butterfly type and must be listed.

2.3.4.2 Check Valves

Check valves must comply with UL 312. Check valves 4 inches and larger must be of the swing type, have a clear waterway and meet the requirements of MSS SP-71, for Type 3 or 4. Inspection plate must be provided on valves larger than 6 inches.

2.3.4.3 Hose Valve

Valve must comply with UL 668.

2.4 ALARM INITIATING AND SUPERVISORY DEVICES

2.4.1 Sprinkler Alarm Switch

Vane or pressure-type flow switch(es). Connection of switch must be by the fire alarm installer. Vane type alarm actuating devices must have mechanical diaphragm controlled retard device adjustable from 10 to 60 seconds and must instantly recycle. The switch shall be tamper resistant and contain two SPDT (Form C) contacts arranged to transfer upon removal of the housing cover, and shall be equipped with a silicone rubber gasket to assure positive water seal and a dustproof cover and gasket to seal the mechanism from dirt and moisture. Switches shall be equipped with screw terminals for each conductor.

2.4.2 Valve Supervisory (Tamper) Switch

Switch must be integral to the control valve or suitable for mounting to the type of control valve to be supervised open. The switch must be tamper resistant and contain SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem. Tamper switches shall be equipped with screw terminals for each conductor.

2.5 BACKFLOW PREVENTION ASSEMBLY

Double-check valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve must have a drain. Backflow prevention assemblies must have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of the specific make, model, design, and size in the FCCCHR List is acceptable as the required documentation.

2.5.1 Backflow Preventer Test Connection

Test connection must consist of a series of listed hose valves with 2 1/2-inch National Standard male hose threads with cap and chain.

2.6 FIRE DEPARTMENT CONNECTION

Fire department connection must be projecting type with cast-brass body, matching wall escutcheon lettered "Auto Spkr" with a polished-brass finish. The connection must have individual self-closing clappers, caps

with drip drains and chains. Female inlets must have 2 1/2-inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963. Comply with UL 405.

2.7 SPRINKLERS

Sprinklers must comply with UL 199 and NFPA 13. Sprinklers with internal O-rings are not acceptable. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters must have temperature classification in accordance with NFPA 13. Extended coverage sprinklers are permitted for loading docks, residential occupancies and high-piled storage applications only.

2.7.1 Pendent Sprinkler

Pendent sprinkler must be recessed quick-response type with nominal K-factor of 5.6. Pendent sprinklers must have a polished chrome finish. Assembly must include an integral escutcheon.

2.7.2 Upright Sprinkler

Upright sprinkler must be brass quick-response typeand have a nominal K-factor of 5.6.

2.7.3 Sidewall Sprinkler

Sidewall sprinkler must be the quick-response recessed type. Sidewall sprinkler must have a nominal K-factor of 5.6. Sidewall sprinkler must have a brass finish.

2.7.4 Dry Sprinkler Assembly

Dry sprinkler assembly must be of the sidewall type as indicated. Assembly must include an integral escutcheon. Maximum length must not exceed maximum indicated in its listing. Sprinkler must have a polished chrome finish.

2.8 ACCESSORIES

2.8.1 Sprinkler Cabinet

Provide spare sprinklers in accordance with NFPA 13 and must be placed in a suitable metal or plastic cabinet of sufficient size to accommodate all the spare sprinklers and wrenches in designated locations. Spare sprinklers must be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed as required by NFPA 13. At least one wrench of each type required must be provided.

2.8.2 Pendent Sprinkler Escutcheon

Escutcheon must be one-piece metallic type with a depth of less than 3/4-inch and suitable for installation on pendent sprinklers. The escutcheon must have a factory finish that matches the pendent sprinkler.

2.8.3 Pipe Escutcheon

Provide split hinge metal plates for piping entering walls, floors, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide

paint finish on metal plates in unfinished spaces.

2.8.4 Sprinkler Guard

Listed guard must be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards must be provided on sprinklers located within 7 feet of the floor and as indicated on the plan.

2.8.5 Relief Valve

Relief valves must be listed and installed at the riser in accordance with NFPA 13.

2.8.6 Air Vent

Air vents must be of the automatic type and piped to drain to the building exterior.

2.8.7 Identification Sign

Valve identification sign must be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gage steel or 0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign must include, but not be limited to "main drain", "auxiliary drain", "inspector's test", "alarm test", "alarm line", and similar wording as required to identify operational components. Where there is more than one sprinkler system, signage must include specific details as to the respective system.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work that is dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative a condition that prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

The installation must be in accordance with the applicable provisions of NFPA 13, NFPA 24 and publications referenced therein. Locate sprinklers in a consistent pattern with ceiling grid, lights, and air supply diffusers. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

a. Piping offsets, fittings, and other accessories required must be furnished to provide a complete installation and to eliminate interference with other construction.

b. Wherever the contractor's work interconnects with work of other trades the Contractor must coordinate with other Contractors to insure all Contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers and similar equipment) that are

concealed above hung ceilings by permanent color coded pins/tabs in the ceiling directly below the item.

c. Provide required supports and hangers for piping, conduit, and equipment so that loading will not exceed allowable loadings of structure. Submittal of a bid must be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

3.2.1 Waste Removal

At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash which may have accumulated during the day as a result of work by the contractor and of his presence on the job. Sidewalks and streets adjoining the property must be kept broom clean and free of waste, debris, trash and obstructions caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities, and property.

3.3 UNDERGROUND PIPING INSTALLATION

The fire protection water main must be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover must be 6 feet or the frost line, whichever is deeper. The supply line must terminate inside the building with a flanged piece, the bottom of which must be set not less than 1-foot above the finished floor. A blind flange must be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block must be provided at the elbow where the pipe turns up toward the floor. In addition, joints must be anchored in accordance with NFPA 24. Buried steel components must be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls must meet the requirements of Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.4 ABOVEGROUND PIPING INSTALLATION

The methods of fabrication and installation of the aboveground piping must fully comply with the requirements and recommended practices of NFPA 13 and this specification section.

3.4.1 Protection of Piping Against Earthquake Damage

Seismic restraint is required. Building is classified as an Occupancy Group IV and as such the Seismic Design Category C. Refer to UFC 3-301-01.

3.4.2 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, must be installed to provide maximum headroom.

3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping must be concealed above ceilings. Piping must be inspected, hydrostatically tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas

must be concealed.

3.4.4 Pendent Sprinklers

a. Drop nipples to pendent sprinklers must consist of minimum 1-inch pipe with a reducing coupling into which the sprinkler must be threaded.

b. Where sprinklers are installed below suspended or dropped ceilings, drop nipples must be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling must not extend below the underside of the ceiling.

c. Recessed pendent sprinklers must be installed such that the distance from the sprinkler deflector to the underside of the ceiling must not exceed the manufacturer's listed range and must be of uniform depth throughout the finished area.

d. Pendent sprinklers in suspended ceilings must be located in the center of the tile (plus or minus 2 inches).

g. Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 12 inches for steel pipe. .

3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers must contain no fittings between the branch line tee and the reducing coupling at the sprinkler.

3.4.6 Pipe Joints

Pipe joints must conform to NFPA 13, except as modified herein. Not more than four threads must show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints must be provided where indicated or required by NFPA 13. Grooved pipe and fittings must be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools must be products of the same manufacturer. For copper tubing, pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.4.7 Reducers

Reductions in pipe sizes must be made with one-piece tapered reducing fittings. When standard fittings of the required size are not manufactured, single bushings of the face or hex type will be permitted. Where used, face bushings must be installed with the outer face flush with the face of the fitting opening being reduced. Bushings cannot be used in

elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2-inch.

3.4.8 Pipe Penetrations

a. Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors must be core-drilled and provided with pipe sleeves. Each sleeve must be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe and extend through its respective wall or floor and be cut flush with each wall surface. Sleeves must provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe must be firmly packed with mineral wool insulation.

b. Where pipes and sleeves penetrate fire walls, fire partitions, or floors, pipes/sleeves must be firestopped in accordance with Section 07 84 00 FIRESTOPPING.

c. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe must be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

d. All penetrations through the boundary of rooms/areas identified as secure space area must meet ICS 705-1.

3.4.9 Escutcheons

Escutcheons must be provided for pipe penetration in finished areas of ceilings, floors and walls. Escutcheons must be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

Unless otherwise indicated, the test connection must consist of 1-inch pipe connected to the remote branch line; a test valve located approximately 7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test". All test connection piping must be inside of the building and penetrate the exterior wall at the location of the discharge orifice only. The discharge orifice must be located outside the building wall no more than 2 feet above finished grade, directed so as not to cause damage to adjacent construction or landscaping during full flow discharge, or to the sanitary sewer. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building. Do not discharge to the roof. Discharge to floor drains, janitor sinks or similar fixtures is not permitted.

Provide concrete splash blocks at all drain and inspector's test connection discharge locations if not discharging to a concrete surface. Splash blocks must be large enough to mitigate erosion and not become dislodged during a full flow of the drain. Ensure all discharged water drains away from the facility and does not cause property damage.

3.4.11 Backflow Preventer

Locate within the building or in a heated enclosure in locations subject to freezing. For heated enclosures, provide a low temperature supervisory alarm connected to the facility fire alarm system. Heat trace is not permitted to be used.

Install backflow preventers so that the bottom of the assembly is a minimum of 6 inches above the finished floor/grade. Install horizontal backflow preventers so that the bottom of the assembly is no greater than 24 inches above the finished floor/grade. Install vertical backflow preventers so that the upper operating handwheel is no more than 6 feet above the finished floor/grade. Clearance around control valve handles must be minimum 6 inches above grade/finished floor and away from walls.

3.4.11.1 Test Connection

Provide downstream of the backflow prevention assembly UL 668 hose valves with 2.5-inch National Standard male hose threads with cap and chain. Provide one valve for each 250 gpm of system demand or fraction thereof. Provide a permanent sign in accordance with paragraph entitled "Identification Signs" which reads, "Test Valve". Indicate location of test header. If an exterior connection, provide a control valve inside a heated mechanical room to prevent freezing.

3.4.12 Drains

a. Main drain piping must be provided to discharge at a safe point outside the building, no more than 2 feet above finished grade. Provide a concrete splash block at drain outlet. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building.

b. Auxiliary drains must be provided as required by NFPA 13. Auxiliary drains are permitted to discharge to a floor drain if the drain is sized to accommodate full flow (min 40 gpm). Discharge to service sinks or similar plumbing fixtures is not permitted.

3.4.13 Installation of Fire Department Connection

Connection must be mounted on the exterior wall approximately 3 feet above finished grade. The piping between the connection and the check valve must be provided with an automatic drip in accordance with NFPA 13 and piped to drain to the outside or a floor drain within the same room.

3.4.14 Identification Signs

Signs must be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Main drain test results must be etched into main drain identification sign. Hydraulic design data must be etched into the nameplates and permanently affixed to each sprinkler riser as specified in NFPA 13. Provide labeling on the surfaces of all feed and cross mains to show the pipe function (e.g., "Sprinkler System", "Fire Department Connection", "Standpipe") and normal valve position (e.g. "Normally Open", "Normally Closed"). For pipe sizes 4-inch and larger provide white painted stenciled letters and arrows, a minimum of 2 inches in height and visible from at least two sides when viewed from the floor. For pipe

sizes less than 4-inch, provide white painted stenciled letters and arrows, a minimum of 0.75-inch in height and visible from the floor.

3.5 ELECTRICAL

Except as modified herein, electric equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Alarm signal wiring connected to the building fire alarm control system must be by the fire alarm installer.

3.6 PAINTING

Color code mark piping red.

3.7 FIELD QUALITY CONTROL

3.7.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level IV Fire Sprinkler Technician, and the representative of the installing company, and reviewed by the QFPE 60 days prior to performing system tests. Detailed test procedures must list all components of the installed system. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 13). The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government final testing.

a. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.7.2 Pre-Government Testing

3.7.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that equipment is functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" and "System Acceptance" as noted in NFPA 13. The Contractor must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 13 and the test reports noted below.

a. NFPA 13 Aboveground Material and Test Certificate

b. NFPA 13 Underground Material and Test Certificate

3.7.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the Contracting Officers Designated Representative (COR). Government final testing will not be scheduled until the COR has received copies of the request for Government final testing and Verification of Compliant Installation letter with all

required reports. Government final testing will not be performed until after the connections to the building fire alarm system have been completed and tested to confirm communications are fully functional. Submit request for test at least 15 calendar days prior to the requested test date.

3.7.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.7.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the COR. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. The contractor's Qualified Fire Protection Engineer (QFPE).

c. Marked-up red line drawings of the system as actually installed.

Government Final Tests will be witnessed by the Contracting Officer, and Qualified Fire Protection Engineer (QFPE). At this time, all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.8 MINIMUM SYSTEM TESTS

The system, including the underground water mains, and the aboveground piping and system components, must be tested to ensure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure must be tested in accordance with NFPA 13 and NFPA 24.

3.8.1 Underground Piping

3.8.1.1 Flushing

Underground piping must be flushed at a minimum of 10 fps in accordance with NFPA 24.

3.8.1.2 Hydrostatic Test

New underground piping must be hydrostatically tested in accordance with NFPA 24.

3.8.2 Aboveground Piping

3.8.2.1 Hydrostatic Test

Aboveground piping must be hydrostatically tested in accordance with NFPA 13. There must be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure must be read from a gauge located at the low elevation point of the system or

portion being tested.

3.8.2.2 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly must be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor must provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5-inch diameter hoses, playpipe nozzles or flow diffusers, calibrated pressure gauges, and pitot tube gauge. The Contractor must provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction loss) across the assembly must be recorded. A metal placard must be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate determined during the preliminary testing. The pressure drop must be compared to the manufacturer's data and the readings observed during the final inspections and tests.

3.8.3 Main Drain Flow Test

Following flushing of the underground piping, a main drain test must be made to verify the adequacy of the water supply. Static and residual pressures must be recorded on the certificate specified in paragraph SUBMITTALS.

3.9 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the final acceptance test.

a. Provide one set of full size paper as-built drawings and schematics. The drawings must be prepared electronically and sized no less than the contract drawings. Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of AutoCAD, and portable document formats of as-built drawings and schematics.

b. Provide operating and maintenance (O&M) instructions.

3.10 ONSITE TRAINING

Conduct a training course for the responding fire department and operating and maintenance personnel as designated by the Contracting Officer. Training must be performed on two separate days (to accommodate different shifts of Fire Department personnel) for a period of 8 hours of normal working time and must start after the system is functionally complete and after the final acceptance test. The on-site training must cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

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PREACTION SPRINKLER SYSTEMS, FIRE PROTECTION
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. For any references below without dates, use the most recent editions of the publications/references.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.4	(2021) Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies
ASSE 1015	(2021) Performance Requirements for Double Check Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA M14	(2024) Manual: Recommended Practice for Backflow Prevention and Cross-Connection Control

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A135/A135M	(2021) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTELLIGENCE COMMUNITY STANDARD (ICS)

ICS 705-1	(2010) Physical and Technical Security Standard for Sensitive Compartmented Information Facilities

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing
NFPA 13	Standard for the Installation of Sprinkler Systems
NFPA 24	Standard for the Installation of Private

	Fire Service Mains and Their Appurtenances
NFPA 37	(2024) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 291	Recommended Practice for Fire Flow Testing and Marking of Hydrants
NFPA 1963	(2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-600-01	(2016; with Change 6, 2021) Fire Protection Engineering for Facilities

UL SOLUTIONS (UL)

UL 199	(2020) UL Standard for Safety Automatic Sprinklers for Fire-Protection Service
UL 262	(2004; Reprint Jul 2023) Gate Valves for Fire-Protection Service
UL 312	(2022) UL Standard for Safety Check Valves for Fire-Protection Service
UL 405	(2013; Bul. 2020) UL Standard for Safety Fire Department Connection Devices
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 521	(1999; Reprint Feb 2023) UL Standard for Safety Heat Detectors for Fire Protective Signaling Systems

UL 668	(2004; Reprint Oct 2021) UL Standard for Safety Hose Valves for Fire-Protection Service
UL 789	(2004; Reprint May 2024) UL Standard for Safety Indicator Posts for Fire-Protection Service
UL 864	(2023) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 SYSTEM DESCRIPTION

Provide single-interlockpreaction sprinkler system(s) in areas indicated on the drawings. Except as modified herein, the system must meet the requirements of NFPA 37, UFC 3-600-01, NFPA 13, NFPA 72. Preaction systems must utilize nitrogen in lieu of air. Pipe sizes which are not indicated on the Contract drawings must be determined by hydraulic calculations.

1.2.1 Hydraulic Design

1.2.1.1 Basis for Calculations

A waterflow test was performed on July 21, 2023 at Buckley SFB and resulted in a static pressure of 77.5 psi with a residual pressure of 30 psi while flowing 1,400 gpm. Perform a new fire hydrant flow test prior to shop drawing submittal in accordance with NFPA 291. Results must include hydrant elevations relative to the building and hydrant number/identifiers for the tested hydrants, including which were flowed, which had a gauge. This information must be presented in a tabular form if multiple hydrants were flowed. The results must be included with the hydraulic calculations. Hydraulic calculations must be based upon the Hazen-Williams formula with a "C" value noted in NFPA 13 for piping, and 100 for existing underground piping. A "C" value of 120 is permitted to be used in hydraulic calculations when nitrogen is utilized. Hydraulic calculations must be based on operation of the fire pump(s) provided in Section 21 30 00 FIRE PUMPS. The minimum residual pressure in a service lateral (lead-in) at the 150% of the fire pump rated flow must be 20 psi at the suction side of the fire pump.

1.2.1.2 Hydraulic Calculations

a. Water supply curves and system requirements must be plotted on semi-logarithmic graph (N^1.85) paper so as to present a summary of the complete hydraulic calculation.

b. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, minimum

discharge pressures and minimum flows. Elevations of hydraulic reference points (nodes) must be indicated.

c. Documentation must identify each pipe individually and the nodes connected thereto. Indicate the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient for each pipe.

d. Where the sprinkler system is supplied by interconnected risers, the sprinkler system must be hydraulically calculated using the hydraulically most demanding single riser. The calculations must not assume the simultaneous use of more than one riser.

e. All calculations must include the backflow preventer manufacturer's stated friction loss at the design flow or 8 psi for double check backflow preventer, whichever is greater.

f. All calculations must be performed back to the actual location of the flow test, taking into account the direction of flow in the service main at the test location.

g. For gridded systems, calculations must show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. A flow diagram indicating the quantity and direction of flows must be included.

1.2.1.3 Design Criteria

Hydraulically design the system to discharge a minimum density of .3 gpm/square foot over the hydraulically most demanding 2,500 square feet of floor area in the Generator Bays and as indicated elsewhere on the drawings. Hydraulic calculations must be in accordance with the Area/Density Method of NFPA 13. Add an allowance for exterior hose streams of 500 gpm to the sprinkler system demand at the point of connection to the existing water system.

1.2.2 Sprinkler Coverage

Sprinklers must be uniformly spaced on branch lines. Provide coverage throughout 100 percent of the building. This includes, but is not limited to, telephone rooms, electrical equipment rooms (regardless of the fire resistance rating of the enclosure), boiler rooms, switchgear rooms, transformer rooms, attached electrical vaults and other electrical and mechanical spaces. Coverage per sprinkler must be in accordance with NFPA 13. Provide sprinklers below all obstructions in accordance with NFPA 13.

1.2.3 System Volume Limitations

Where the volume of an individual system piping exceeds 500 gallons, provide the dry pipe valve with a quick-opening device. The maximum system capacity controlled by one dry pipe valve must not exceed 750 gallons, unless it complies with the dry pipe system water delivery calculations noted in NFPA 13.

1.2.4 Control System

The control system must meet the requirements of NFPA 72. The control unit must be listed for "Releasing Device Service". The control unit and the solenoid valve that activates the water control valves must be compatible with each other. Compatibility must be in accordance with the specific listing of the control equipment.

1.2.4.1 Circuit Requirements

Connect alarm initiating devices to initiating device circuits (IDC), Class A or to signal line circuits (SLC), Class A, in accordance with NFPA 72. Provide a separate circuit for actuation of each individual automatic water control valve. Fully supervise the circuits that actuate the water control valves so that the occurrence of a single open or a single ground fault condition in the interconnecting conductors will be indicated at the control unit.

1.2.5 System Operational Features

Include in the system a detection system, manual actuation stations, supervisory and alarm switches, control unit and associated equipment. Provide preaction sprinkler system piping with supervisory nitrogen pressure not to exceed 30 psig.

1.2.5.1 System Actuation

Activation of a single heat detector or a single manual actuation station must actuate alarm zone circuits of the control unit that, in turn, actuate the corresponding automatic water control valve. Actuation of the automatic water control valve must cause water to fill the discharge piping after loss of nitrogen pressure.

1.2.5.2 Alarm Functions

Activation of a heat detector, sprinkler pressure (waterflow) alarm switch or manual actuation station must cause the illumination of the respective device at the RSCP, activation of the building fire alarm system, and transmission of the alarm to the base-wide fire reporting system.

1.2.5.3 Supervisory Functions

The reduction of supervisory nitrogen pressure within the sprinkler system piping to less than 15 psi or the increase in nitrogen pressure more than 10 psi above normal set pressure must be transmitted to the building fire alarm system via the releasing control unit as a supervisory condition. Valve tamper switches must be monitored by the releasing control unit and transmitted to the building fire alarm system as a supervisory condition.

1.2.6 Qualified Fire Protection Engineer (QFPE)

An individual who is a licensed professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience. Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness

and compliance with the provisions of this specification. Working (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Provide a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting all outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government and final Government functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

The submittal requirement for the Qualified Fire Protection Engineer (QFPE) is found in Section 28 31 70 and applies to all Sections in which the requirement for Qualified Fire Protection Engineer (QFPE) is present.

1.3 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Partial submittals and submittals not fully complying with NFPA 13 and this specification section must be returned disapproved without review. SD-02, SD-03 and SD-05 must be submitted simultaneously.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE must be returned disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sprinkler System Designer; G, DO

Sprinkler System Installer; G, DO

Releasing System Designer; G, DO

Releasing System Technician; G, DO

Releasing System Installer; G, DO

Nitrogen Generation System Commissioning Technician; G, DO

Releasing System Site-Specific Software Acknowledgement; G, DO

SD-02 Shop Drawings

Shop Drawing; G, DO

Wiring Diagrams; G, DO

Control System Layout; G, DO

Battery Power (RSCP); G, DO

Voltage Drop Calculations (RSCP); G, DO

SD-03 Product Data

Pipe; G, DO

Fittings; G, DO

Valves, including gate, check,and globe; G, DO

Relief Valves; G, DO

Sprinklers; G, DO

Pipe Hangers and Supports; G, DO

Sprinkler Alarm Switch; G, DO

Valve Supervisory (Tamper) Switch; G, DO

Fire Department Connection; G, DO

Backflow Prevention Assembly; G, DO

Hose Valve; G, DO

Seismic Bracing; G, DO

High/Low-Nitrogen Pressure Supervisory Switch; G, DO

Pre-Action Valve; G, DO

Nitrogen Generation System; G, DO

Releasing Service Fire Alarm Control Panel (RSCP); G, DO

Terminal Cabinets; G, DO

Auxiliary Power Supply Panels; G,DO

Nameplates; G, RO

Batteries (RSCP); G, DO

Battery Chargers; G, DO

Heat Detectors; G, DO

Addressable Interface Devices (RSCP); G, DO

Addressable Control Modules (RSCP); G, DO

Isolation Modules; G,DO

Surge Protective Devices; G, DO

SD-05 Design Data

Seismic Bracing; G, DO

Load calculations for sizing of seismic bracing

Hydraulic Calculations; G, DO

Voltage Drop Calculations (RSCP); G, DO

SD-06 Test Reports

Test Procedures; G, RO

SD-07 Certificates

Verification of Compliant Installation; G, RO

Request for Government Final Test; G, RO

SD-10 Operation and Maintenance Data

Operating and Maintenance (O&M) Instructions; G, RO

Spare Parts Data; G, RO

SD-11 Closeout Submittals

As-built drawings, RO

Document Storage Cabinet; G, RO

Initiating Devices; G, RO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 TECHNICAL DATA AND SITE-SPECIFIC SOFTWARE

Technical data and site-specific software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be required in other specifications, must be delivered, strictly in accordance with the CONTRACT CLAUSES. The releasing system manufacturer must submit written confirmation of this contract provision as "Releasing System Site-Specific Software Acknowledgement". Identify data delivered by reference to the specification paragraph against which it is furnished. Data to be submitted must include complete system, equipment, and software descriptions. Descriptions must show how the equipment will operate as a system to meet the performance requirements of this contract. The site-specific software data package must include the following:

a. Items identified in NFPA 72, titled "Site-Specific Software".

b. Identification of programmable portions of the system equipment and capabilities.

c. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

d. Provision of operational software data on all modes of programmable portions for foam releasing system.

e. Description of releasing system equipment operation.

f. Description of auxiliary and remote equipment operations.

g. Library of application software.

h. Operation and maintenance manuals.

1.5 QUALITY ASSURANCE

1.5.1 Preconstruction Submittals

Within 36 days of contract award but no less than 14 days prior to commencing work on site, the prime Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications will be returned Disapproved Without Review.

1.5.1.1 Shop Drawing

6 copies of the shop drawings, no later than 28 days prior to the start of system installation. Working drawings conforming to the requirements prescribed in NFPA 13 and must be no smaller than ANSI D. Each set of drawings must include the following:

1. A descriptive index with drawings listed in sequence by number. A legend sheet identifying device symbols, nomenclature, and conventions used in the package.

2. Floor plans drawn to a scale not less than 1/8-inch equals 1-foot clearly showing locations of devices, equipment, risers, electrical power connections and other details required to clearly describe the proposed arrangement.

3. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross mains and branch lines to finished floor and roof or ceiling. A detail must show the dimension from the sprinkler and sprinkler deflector to the ceiling in finished areas.

4. Longitudinal and transverse building sections showing typical branch line and cross main pipe routing, elevation of each typical sprinkler above finished floor and elevation of "cloud" or false ceilings in relation to the building ceilings.

5. Plan and elevation views which establish that the equipment will fit the allotted spaces with clearance for installation and maintenance.

6. Riser layout drawings drawn to a scale of not less than 1/2-inch equals 1-foot to show details of each system component, clearances between each other and from other equipment and construction in the room.

7. Details of each type of riser assembly, pipe hanger, sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring. The dimension from the edge of vertical piping to the nearest adjacent wall(s) must be indicated on the drawings when vertical piping is located in stairs or other portions of the means of egress.

8. Details of each type of pipe hanger, seismic bracing/restraint and related components.

9. Include fire pump curve with shop drawings and hydraulic calculations.

10. The calculated volume of each system.

11. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the RSCP and remote fire alarm control units, initiating circuits, switches, relays and terminals.

12. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

13. See coordinated submittal requirements regarding this submittal item with respect to impacted submittal content by other trades, most notably alterations and accommodations of footing reinforcement for water entrance with vertical routing through the footings.

1.5.1.2 Wiring Diagrams

Copies of point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems which are supervised or controlled by the system. Diagrams must show connections from field devices to the FACU and remote FACU, initiating circuits,

switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

Provide a schedule of connections for the fire alarm, intercom/public address, releasing service, HVAC system, power system, and any other connected systems and all associated interfaces.

1.5.1.3 Control System Layout

Copies of plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors, control equipment, alarm and supervisory signal initiating devices, alarm notification appliances, supervising station fire alarm system transmitter, and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide systems complete and ready for operation.. Indicate candela rating of each visual notification appliance and wattage and decibel rating of each audible notification appliance. Clearly identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, etc. Clearly identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, and similar. Indicate if the environment for the control equipment is within its environmental listing (e.g. temperature/humidity).

Provide a complete description of the system operation in matrix format capturing the items identified in the (and of formatting similar to the) Functional Matrices and the requirements of the related specification sections listed herein.

1.5.1.4 Notification Appliances

Requirements for the notification appliances are in Section 28 31 70. All building notification appliances are powered and controlled by the fire alarm system, to which the releasing service communicates.

1.5.1.5 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings. See Section 28 31 70 for requirements.

1.5.1.6 Battery Power

Provide battery calculations as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

1.5.1.7 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that

sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.5.1.8 Product Data

6 copies of annotated catalog data to show the specific model, type, and size of each item. Catalog cuts must indicate the NRTL listing. The data must be highlighted to show model, size, options, and other pertinent information, that are intended for consideration. Data must be adequate to demonstrate compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

1.5.1.9 Hydraulic Calculations

Calculations must be as outlined in NFPA 13 except that calculations must be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Calculations must include isometric diagram indicating hydraulic nodes and pipe segments. Include fire pump curve with submittal. Calculations must include fire pump operation.

1.5.1.10 Voltage Drop Calculations

Voltage drop calculations for each notification circuit indicating that sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Include the calculations on the system layout drawings.

1.5.1.11 Operating and Maintenance (O&M) Instructions

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA as supplemented and modified by this specification section.

Provide six manuals and one pdf version on electronic media. The manuals must include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment.

Submit spare parts data for each different item of material and equipment specified. The data must include a complete list of parts and supplies, and a list of parts recommended by the manufacturer to be replaced after 1-year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

1.5.2 Qualifications

1.5.2.1 Sprinkler System Designer

The sprinkler system designer must be certified as a Level III Technician

by National Institute for Certification in Engineering Technologies (NICET) in the Water-Based Systems Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7.

1.5.2.2 Sprinkler System Installer

The sprinkler system installer must be regularly engaged in the installation of the type and complexity of system specified in the contract documents, and must have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.5.2.3 Releasing System Designer

The system designer must be certified as a Level III (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7, or meet the qualifications for a QFPE.

1.5.2.4 Releasing System Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.5.2.5 Releasing System Installer

Fire alarm installer with a minimum of two years of experience utilized to assist in the installation of devices, cabinets and control units. NICET Level II technician to assist in the installation of devices, cabinets and control units. A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.5.2.6 Nitrogen Generation System Commissioning Technician

Commissioning technician of nitrogen generation system(s) must have one of the following qualifications. Qualifications must be provided prior to preliminary inspection and tests.

a. Commissioning of nitrogen generation system must be carried out by technician employed by and certified by the nitrogen generation system manufacturer.

b. In lieu of manufacturer's commissioning technician, the fire sprinkler contractor must provide proof their commissioning technician has manufacturer's certified training for the equipment being installed and proof of at least five previous installations of manufacturer's equipment where the contractor's commissioning technician has successfully conducted commissioning under the direct supervision of the manufacturer's commissioning representative. Contractor must provide proof the five supervised commissioning occurred AFTER contractor's commissioning agent has obtained the certified training. Commissioning carried out prior to factory training, or without supervision of manufacturer's technician or commissioning of other

manufacturer's equipment does not qualify as applicable experience. Conduct preliminary inspections and testing does not qualify as applicable experience.

1.5.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of an item of equipment described must not be construed as waiving this requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation are mandatory requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. All pipes must be either capped or plugged until installed.

1.7 EXTRA MATERIALS

Spare sprinklers and wrench(es) must be provided as spare parts in accordance with NFPA 13.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials, equipment, and devices listed for fire protection service when so required by NFPA 13 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for a classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid.

2.1.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Nameplates must be etched metal or plastic, permanently attached by screws to control units, panels or adjacent walls.

2.1.3 Identification and Marking

Pipe and fitting markings must include name or identifying symbol of manufacturer and nominal size. Pipe must be marked with ASTM designation. Valves and equipment markings must have name or identifying symbol of manufacturer, specific model number, nominal size, name of device, arrow indicating direction of flow, and position of installation (horizontal or vertical), except if valve can be installed in either position. Markings must be included on the body casting or on an etched or stamped metal nameplate permanently on the valve or cover plate.

2.1.4 Keys

Keys and locks for equipment, control units, panels and devices must be identical. Master all keys and locks to a single key as required by the Installation Fire Department. Keys must be CAT 60.

2.1.5 Pressure Ratings

Valves, fittings, couplings, alarm switches, and similar devices must be rated for the maximum working pressures that can be experienced in the system, but in no case less than 175 psi.

2.1.6 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the instructions on the interior of the RSCP. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.2 UNDERGROUND PIPING COMPONENTS

2.2.1 Pipe

Pipe must comply with NFPA 24. Minimum pipe size is 6 inches. Piping more than 5 feet outside the building walls must comply with Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING. A continuous section of welded stainless steel fire water service piping from a point outside the building perimeter to a flanged fitting at least 1-foot above the finished floor within the building is acceptable.

2.2.2 Fittings and Gaskets

Fittings must be ductile-iron conforming to AWWA C110/A21.10 with cement mortar lining conforming to AWWA C104/A21.4. Gaskets must be suitable in design and size for the pipe with which such gaskets are to be used. Gaskets for ductile-iron pipe joints must conform to AWWA C111/A21.11.

2.2.3 Gate Valve and Indicator Posts

Installation must comply with NFPA 24. Gate valves for use with indicator post must conform to UL 262. Indicator posts must conform to UL 789. Provide each indicator post with one coat of primer and two coats of red enamel paint.

2.2.4 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape, 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold block letters continuously and repeatedly over the entire tape length. Warning and identification must read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.3 ABOVEGROUND PIPING COMPONENTS

2.3.1 Steel Piping Components

2.3.1.1 Steel Pipe

Except as modified herein, steel pipe must be black as permitted by NFPA 13 and conform to the applicable provisions of ASTM A53/A53M, ASTM A135/A135M or ASTM A153/A153M.

Steel pipe must be Schedule 40 only. Grooved pipe must be cut-grooved.

2.3.1.2 Fittings

Fittings must be welded, threaded, or grooved-end type. Threaded fittings must be cast-iron conforming to ASME B16.4, malleable-iron conforming to ASME B16.3 or ductile-iron conforming to ASTM A536. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe, steel press fittings and field welded fittings are not permitted. Fittings, mechanical couplings, and rubber gaskets must be supplied by the same manufacturer. Threaded fittings must use Teflon tape or manufacturer's approved joint compound. Saddle tees using rubber gasketed fittings are not permitted. Reducing couplings are not permitted except as allowed by NFPA 13.

2.3.1.3 Grooved Mechanical Joints and Fittings

Joints and fittings must be designed for not less than 175 psi service and must be the product of the same manufacturer. Field welded fittings must not be used. Fitting and coupling housing must be malleable-iron conforming to ASTM A47/A47M, Grade 32510; ductile-iron conforming to ASTM A536, Grade 65-45-12. Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 2 inches and larger. Gasket must be of silicon compound and listed for dry fire protection systems. Gasket must be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts must be heat-treated steel conforming to ASTM A183 and must be cadmium-plated or zinc-electroplated.

2.3.1.4 Flanges

Flanges must conform to NFPA 13 and ASME B16.1. Gaskets must be non-asbestos compressed material in accordance with ASME B16.21, 1/16-inch thick, and full face or self-centering flat ring type.

2.3.2 Pipe Hangers and Supports

Provide galvanized pipe hangers,supports, and seismic bracing in accordance with NFPA 13. Design and install seismic protection in accordance with the requirements of NFPA 13 section titled "Protection of Piping Against Damage Where Subject to Earthquakes for Seismic Design Category "D".

2.3.3 Valves

Provide valves of types approved for fire service. Valves must open by counterclockwise rotation.

2.3.3.1 Control Valve

Manually operated sprinkler control/gate valve must be outside stem and yoke (OS&Y) type and must be listed.

2.3.3.2 Check Valves

Check valves must comply with UL 312. Check valves 4 inches and larger must be of the swing type, have a clear waterway and meet the requirements of MSS SP-71, for Type 3 or 4. Inspection plate must be provided on valves larger than 6 inches.

2.3.3.3 Hose Valve

Valve must comply with UL 668.

2.4 AUTOMATIC WATER CONTROL VALVE (PRE-ACTION VALVE)

Automatic water control valve (pre-action valve) must be electrically -actuated and rated for a working pressure of 175 psi. Valve must be capable of being reset without opening the valve. Electrical solenoid valve used to actuate the water control valve must be an integral component of the valve or must be approved for use by the water control valve manufacturer. Solenoid valve must be rated at 24 volts direct current, and must be normally closed type that operates when energized. Solenoid valves must be rated for a maximum pressure differential of 175 psi. Water control valve must be equipped with a means to prevent the valve from returning to the closed position until being manually reset. Assembly must be complete with the valve manufacturer's standard trim piping, drain and test valves, pressure gauges, and other required appurtenances. Include with each assembly an emergency release device for manually tripping the water control valve in the event of a power or other system failure. Device must be a standard accessory component of the valve manufacturer and labeled as to its function and method of operation. Valves located in hazardous locations must be approved for the hazard classification of the area where located.

2.5 SUPERVISORY NITROGEN SYSTEM

Provide a nitrogen supply system in accordance with NFPA 13. The connection pipe from the nitrogen generator must not be less than 1/2-inch in diameter and must enter the system above the priming water level of the dry pipe valve. Install a check valve in the system supply nitrogen piping from the generator. A shutoff valve of the renewable disc type must be installed upstream of this check valve. The nitrogen supply system must be sized to pressurize the sprinkler system to 40 psi within 20 minutes.

2.5.1 Nitrogen Generation System

The nitrogen generation system (NGS) must be installed with a compressor sized appropriately for the application and capable of achieving system pressure within 30 minutes in accordance with the requirements of NFPA 13. The nitrogen generation system must be designed to achieve a nitrogen concentration of 98% or greater and maintain that concentration within the fire sprinkler system continuously. The output nitrogen quality must be confirmed by using a gas stream analyzer. Where multiple preaction sprinkler risers are present, provide a manifold adjacent to the preaction sprinkler risers. Manifold system must include automatic vent and air

maintenance devices for each sprinkler system riser. Nitrogen generation system requires a dedicated, hardwired 120V AC power supply.

2.5.1.1 Design of Nitrogen Generation System

Design the system so all equipment is installed within the confines of the riser room with the exception of a connection for a manual or automatic gas analyzer. Provide a system that is capable of delivering a minimum of 98 percent nitrogen composition throughout all of the system piping within 14 days from the commencement of the inerting process. Provide membrane type nitrogen generators that provide "instant on-instant off" nitrogen gas production without the need for nitrogen storage tanks. The complete nitrogen generator system must be self-contained and skid mounted with "drop-in" operability with a simple one step direct connection of the nitrogen gas supply line to each zone/riser. Provide an automatic "fill and purge" breathing process. This must be done while the sprinkler system is fully functional and must not alter the design performance of the sprinkler system. A process that involves continuous venting of the piping network is not permitted. Air maintenance devices used in conjunction with the nitrogen generation system must be listed for use on sprinkler systems. At the riser and at the end of each zone, provide a connection for a manual gas analyzer.

2.5.1.2 Nitrogen Air Compressor

Air compressors to be used in conjunction with the nitrogen generator must be capable of the following:

a. Capable of producing a continuous stream of compressed air at 100+ psig.

b. Capable of automatic cut in and cut out.

c. Equipped with an on-board after-cooler.

d. Equipped with an on-board automatic water blow down system.

e. Equipped with vibration dampening system.

f. Equipped with an air storage tank to provide continuous delivery of compressed air to the nitrogen generator.

g. Rated for continuous duty service.

h. Compressors less than 3.0 hp must be an oil-less design.

i. Oil-less compressors must be such that the manufacturer has designed the oil-less compressor to provide 5000 hours of continuous duty service before requiring a gasket and seal rebuild.

2.5.1.3 Nitrogen Venting Device

The functional component of the nitrogen venting device for use in the "fill and purge" breathing process must:

a. Be NRTL listed for use on sprinkler systems.

b. Not require plumbing to drain.

c. Close automatically at the completion of the nitrogen inerting process without manual intervention.

d. Be installed on each zone in the riser room.

2.5.1.4 Supervision of Nitrogen Generator

Nitrogen generator must be able to provide the following monitoring options:

a. Power supply "on" for nitrogen generators.

b. Power supply "on" for compressor.

c. Amp draw for compressor.

d. Line pressure (psig).

e. Nitrogen purity at discharge (sample port for use with manual gas analyzer).

2.5.2 Nitrogen Pressure Maintenance Device

Device must be a pressure regulator that automatically reduces supply air pressure to the minimum pressure required to be maintained in the piping system. The device must have a cast bronze body and valve housing complete with diaphragm assembly, spring, filter, ball check to prevent backflow, 1/16-inch restriction to prevent rapid pressurization of the system, and adjustment screw. The device must be capable of reducing maximum inlet pressure of 100 psi to a fixed outlet pressure adjustable to 20 psi.

2.6 ALARM INITIATING AND SUPERVISORY DEVICES

2.6.1 Sprinkler Alarm Switch

Pressure-type flow switch(es). Connection of switch must be by the fire alarm installer. Switches shall be equipped with a built-in adjustable retard to provide a time delay from 0 to 60 second. The device shall be a UL listed extinguishing system attachment rated for the particular pressure and location that it is installed. Switches shall be equipped with screw terminals for each conductor.

2.6.2 High/Low-Nitrogen Pressure Supervisory Switch

Each automatic water control valve must be provided with a nitrogen pressure switch connected to the control unit. The pressure switch must supervise the nitrogen pressure in the system and must be set to activate at 10 psi above the automatic water control valve trip point pressure (low) and 10 psi above normal nitrogen pressure (high). The switch must have an adjustable range between 5 and 80 psi. The switch must have screw terminal connection and must be capable of being wired for normally open or normally closed circuit.

2.6.3 Valve Supervisory (Tamper) Switch

Switch must be integral to the control valve or suitable for mounting to the type of control valve to be supervised open. The switch must be tamper resistant and contain SPDT (Form C) contacts arranged to transfer

upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem. Tamper switches shall be equipped with screw terminals for each conductor.

2.7 BACKFLOW PREVENTION ASSEMBLY

Double-check valve assembly backflow preventer complying with ASSE 1013, ASSE 1015 and AWWA M14. Each check valve must have a drain. Backflow prevention assemblies must have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List" and be listed for fire protection use. Listing of the specific make, model, design, and size in the FCCCHR List is acceptable as the required documentation.

2.7.1 Backflow Preventer Test Connection

Test connection must consist of a series of listed hose valves with 2 1/2-inch National Standard male hose threads with cap and chain.

2.8 FIRE DEPARTMENT CONNECTION

Fire department connection must be projecting type with cast-brass body, matching wall escutcheon lettered "Auto Spkr" with a polished-brass finish. The connection must have individual self-closing clappers, caps with drip drains and chains. Female inlets must have 2 1/2-inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963. Comply with UL 405.

2.9 SPRINKLERS

Sprinklers must comply with UL 199 and NFPA 13. Sprinklers with internal O-rings are not acceptable. Sprinklers in high heat areas including attic spaces or in close proximity to unit heaters must have temperature classification in accordance with NFPA 13. Sprinklers in the Generator Bays must be considered in high heat areas. Extended coverage sprinklers are permitted for loading docks. Sprinklers for preaction systems must be automatic, fusible solder or glass bulb type.

2.9.1 Pendent Sprinkler

Pendent sprinkler must be of the dry pendent type, unless otherwise indicated. Pendent sprinkler must be quick-response dry pendent type with nominal K-factor of 8.0. Pendent sprinklers must have a polished chrome finish. Assembly must include an integral escutcheon.

2.9.2 Upright Sprinkler

Upright sprinkler must be brass quick-response type with a nominal K-factor of 8.0.

2.9.3 Sidewall Sprinkler

Sidewall sprinkler must be the quick-response type. Sidewall sprinkler must have a nominal K-factor of 8.0. Sidewall sprinkler must have a polished-chrome finish.

2.10 ACCESSORIES

2.10.1 Sprinkler Cabinet

Spare sprinklers must be provided in accordance with NFPA 13 and must be placed in a suitable metal or plastic cabinet of sufficient size to accommodate all the spare sprinklers and wrenches in designated locations. Spare sprinklers must be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed as required by NFPA 13. At least one wrench of each type required must be provided.

2.10.2 Pendent Sprinkler Escutcheon

Escutcheon must be one-piece metallic type with a depth of less than 3/4-inch and suitable for installation on pendent sprinklers. The escutcheon must have a factory finish that matches the pendent sprinkler.

2.10.3 Pipe Escutcheon

Provide split hinge metal plates for piping entering walls, floors, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.10.4 Sprinkler Guard

Listed guard must be a steel wire cage designed to encase the sprinkler and protect it from mechanical damage. Guards must be provided on sprinklers located within 7 feet of the floor.

2.10.5 Relief Valve

Relief valves must be listed and installed at there riser in accordance with NFPA 13.

2.10.6 Identification Sign

Valve identification sign must be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gage steel or 0.024-inch aluminum with red letters on a white background or white letters on red background. Wording of sign must include, but not be limited to "main drain", "auxiliary drain", "inspector's test", "alarm test", "alarm line", and similar wording as required to identify operational components. Where there is more than one sprinkler system, signage must include specific details as to the respective system.

2.11 Releasing Service Fire Alarm Control Panel (RSCP)

Provide a RSCP for the control and release of the preaction systems. Design the system so the loss of a FACP or another RSCP (where applicable) in the fire alarm system does not prohibit the RSCP from functioning as intended. Do not connect the RSCP to other control unit through the use of a network cable. Communicate functionality between panels through addressable modules only. Use discrete dry contact input/output points only. Coordinate with functional matrices. Provide minimum eight (8) spare input discrete contacts and eight (8) spare output discrete contacts for future use on each panel.

A common RSCP may control multiple releasing systems or agents.

Panel(s) shall be provided with cylinder lock. Control panel shall be a clean, uncluttered, and orderly factory assembled and wired unit

The RSCP is shown on the FA sheets in an area meeting the environmental conditions of UFC 3-600-01. Do not locate the RSCP in an electrically classified hazardous area nor in an area subject to water spray/runoff. Regardless of environmental conditions, do not provide openings or conduit entry into the top of the RSCP.

All detectors shall be listed for use with panel.

Panel shall be UL listed or FM approved for "Releasing Device Service" or shall have modules approved for this purpose. Panel shall contain all components and equipment required to provide the specified operational and supervisory functions of the system. Control panel shall be a clean, uncluttered, and orderly factory assembled and wired unit.

The RSCP must be listed, analog-addressable and compatible with the system, devices and functions specified. Route all supervision of the RSCP through the main FACU. The RSCP must perform all functions necessary to operate the system detection, actuation, and auxiliary functions independent of the FACU. The control system must be microprocessor-based utilizing distributed processing concept. A single microprocessor failure must not impact operation of additional modules on the system. The control system must be capable of supporting an air aspirating smoke detection system. The control system's initiating circuits must be capable of Class A or Class B operation. The solenoid must be listed for use with the releasing unit and extinguishing equipment. Each circuit must be capable of monitoring contact devices configured for manual release, trouble input or auxiliary (non-fire) input. The RSCP must contain release circuits for activation of an extinguishing systems. Each release circuit must be capable of Class A or Class B operation. The RSCP must contain at least two notification appliance circuits for annunciation. Each notification circuit must be capable of Class A or Class B operation. Provide alarm/trouble reset switches to reset a cleared device in alarm or trouble. Alarm or trouble signals are not to be self-restoring without activating the switch.

Alarm initiating devices shall be connected to signal line circuits (SLC), Style 6, in accordance with NFPA 72. A looped conduit system and Class A wiring shall be provided so that if the conduit and all conductors within are severed at any point, all IDC, NAC, and SLC will remain functional. Under no circumstance shall system release foam agent upon a short-to-ground condition.

Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory, or trouble signals.

The panel shall have prominent rigid plastic or metal identification plates for lamps, zones, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. Provide a suitable means for testing the working condition and accuracy of the control panel visual indicating devices (meter and lamps). Meters and lamps shall be plainly visible when the cabinet door is closed. Panel shall include integral "power on," "alarm," and "trouble" lamps with annunciation of

each alarm, supervisory, and trouble signal.

Annunciator must be integral with the RSCP. Annunciation must be by an indicator lamp, alphanumeric display, or other equivalent means in which each indication provides status information about a circuit, condition, or location and visible through the cabinet door. Supervision is not required provided that a fault in the annunciator circuits results only in loss of annunciation and does not affect the normal functional operation of the remainder of the system. Ensure each visible indicator provides specific identification of the device. Do not use generic nondescript wording such as "Zone 1", or "Zone 2", for the label identification.

An operator at the RSCP, having the proper access level must have the capability to manually access the following information for each initiating device:

a. Primary status.

b. Device type.

c. Present average value.

d. Present sensitivity selected.

e. Sensor range (normal, dirty, etc).

2.11.1 Cabinet

Install control panel components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of panels as well as field wiring. The enclosure shall be identified by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall say "Releasing Service Fire Alarm Control Panel" and shall not be less than 1 inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches. The cabinet shall be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.

2.11.2 Control Modules

Provide power and control modules to perform all functions of the RSCP. Provide audible signals to indicate any alarm, supervisory, or trouble condition. The alarm signals shall be different from the trouble signal. Connect circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and resistors, if any, on screw terminals in the RSCP. Circuits operating at 24 VDC shall not operate at less than the UL listed voltage at the sensor or appliance connected. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage.

Silencing Switches

2.11.3 Alarm Silencing Switch

Provide an alarm silencing switch at the RSCP which shall silence the audible and visual. This switch shall be overridden upon activation of a subsequent alarm.

2.11.4 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch which shall silence the audible trouble and supervisory signal, but not extinguish the visual indicator. This switch shall be overridden upon activation of a subsequent alarm, supervision, or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated.

2.11.5 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Circuits shall be manually reset by switch from the RSCP after the initiating device or devices have been restored to normal.

2.11.6 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.11.7 Field Programmability

Provide control units and control panels which are fully field programmable for control, initiation, notification, supervisory, and trouble functions of both input and output. The system program configuration shall be menu driven. System changes shall be password protected and shall be accomplished using personal computer-based equipment. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract.

2.11.8 Input/Output Modifications

The RSCP shall contain features which allow the bypassing of input devices from the system or the modification of system outputs. These control features shall consist of a panel-mounted keypad and a keyboard. Any bypass or modification to the system shall indicate a trouble condition on the RSCP.

2.11.9 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.11.10 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the instructions on the interior of the RSCP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions (normal, alarm, supervisory, and trouble). The instructions shall be approved by the Contracting Officer before being posted.

2.11.11 History Logging

The control panel shall have the ability to store a minimum of 400 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control panel shall not clear the memory.

2.11.12 Heat Detector Self-Test Routines

Automatic self-test routines must be performed on each detector that will functionally check detector sensitivity electronics and ensure the accuracy of the value being transmitted. Any detector that fails this test must indicate a trouble condition with the detector location at the control unit.

2.12 ANNUNCIATOR

2.12.1 Remote Annunciator Panel

A remote annunciator is provided in Section 28 31 70 Subpart "LCD Annnunciator". The preaction releasing service control panel reports to the fire alarm control panel and to the transceiver (see FA600 series sheets).

2.12.2 Graphic Annunciator Panel

A map is provided in Section 28 31 70 Subpart "LCD Annnunciator" to include a map at the annunciator location; there are not a large number of concealed devices warranting a Graphic Annunciator Panel in this building.

2.12.2.1 Materials

Construct the graphic annunciator face plate of non-glare matte finish. The face plate must be backlit with LEDs. Control equipment and wiring must be housed in a surface mounted back box. The exposed portions of the back box must be chrome plated without knockouts.

2.12.2.2 Programming

Where programming for the operation of the graphic annunciator is accomplished by a separate software program other than the software for the RSCP, the software program must not require reprogramming after loss of power. The software must be reprogrammable in the field.

2.13 HEAT DETECTORS

2.13.1 Heat Detectors

Heat detectors must be designed for detection of fire by fixed temperature in accordance with UL 521. The alarm condition must be determined by comparing detector value with the stored values. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations as defined by NFPA 70, must be types approved for such locations.
Heat detectors in the Generator Bays must be rated at 190 Degrees Fahrenheit. The detector assembly must be explosionproof where indicated.

2.13.1.1 Fixed Temperature Detectors

Detectors must be surface mounted in the horizontal orientation and

supported independently of wiring connections. Detectors must be self-restoring. The detectors must have a specific temperature setting of 135 degrees F. The detector assembly must be weatherproof. Detectors in the Generator Bays must be 190 degrees F. The detector assembly must be explosionproof where indicated.

2.14 ADDRESSABLE INTERFACE DEVICES (RSCP)

See Section 28 31 70 for requirements.

2.15 ADDRESSABLE CONTROL MODULES (RSCP)

See Section 28 31 70 for requirements.

2.16 ISOLATION MODULES

See Section 28 31 70 for requirements, except the faults are to be reported to the RSCP rather than the FACU.

2.17 ELECTRICAL

2.17.1 Wiring

See Section 28 31 70 for requirements.

2.17.2 Alarm Wiring

See Section 28 31 70 for requirements.

2.18 SURGE PROTECTIVE DEVICES

Surge protective devices must be provided to suppress all voltage transients which might damage RSCP components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on the signaling line circuits. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the releasing control unit breaker is located.

a. Surge protective devices for nominal 120 VAC must be UL 1449 listed with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. A unit fusing must be externally accessible.

b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be UL 497B listed, meet IEEE C62.41.1 and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for releasing system wiring. The base assembly must accept "plug-in" surge

protective module.

c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:

(1) For 120 VAC nominal line voltage: UL 1449 and UL 1283 listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.

(2) For 24-volt nominal line voltage: UL 497B listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.

(3) For alarm telephone dialers: UL 497A listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.

(4) For IP-DACTS: UL 497B listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

See Section 28 31 70 for additional requirements.

2.19 ELECTRIC POWER

2.19.1 Primary Power

Power must be 120 VAC 60 Hz service for the RSCP from the AC service to the building in accordance with NFPA 72.

2.20 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.20.1 Batteries (RSCP)

Provide sealed, maintenance-free, sealed lead acid batteries as the source for emergency power to the RSCP. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

The battery cabinet shall have adequate space for spare duplicate storage batteries. Batteries shall not be located outside of enclosures, whether with the equipment the batteries are supplying or remotely located. Include product data for battery cabinets when located remote from the equipment it serves. Batteries shall be mounted on a noncorrosive and nonconductive base or pad.

2.20.1.1 Capacity

Battery size must apply to every control unit and panel associated with this system, including auxiliary power supply panels and fire alarm

transmitters.

a. Sufficient capacity to operate the releasing service system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes (or minimum required time for automatice water control valve release).

b. While the conditions of NFPA 72 §10.6.7.3.1(2) and NFPA 72 §10.6.11.3.1 may be present and supplying the fire alarm system in this facility, the Tri-Services (Army, Air Force (including Space Force), Navy (including Marine Corps) Fire Protection Discipline Working Group (DWG) has indicated via the criteria change request process the battery capacity indicated in the previous item is not to be curtailed regardless of the presence of supply to the fire alarm system by an NFPA 70 Article 700 Emergency System (CCR 16194).

2.20.1.2 Battery Power (RSCP) Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements for the criteria noted in the paragraph "Capacity" above.

(1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each system component and each control unit or panel component, and compliance with UL 864.

(2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

(3) Provide voltage drop calculations (RSCP) to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of the system operating on batteries. Calculations must be performed using the minimum rated voltage of each component. Identify on device data and calculations the minimum operable voltage per manufacturer recommendations for all devices requiring power, and identify special device features to be used where the delivered voltage does not satisfy the manufacturer's standard voltage range. Include the calculations on the system layout drawings.

(4) Calculations including ampere-hour requirements for each system component and each panel component, and the battery recharging period, shall be included on the drawings.

b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing devices, appliances, or combination of devices and appliances remote from the power sources.

2.20.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the

connected system load and maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided. Provide calculations demonstrating recharge duration requirements are satisfied.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work that is dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative all conditions that prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

The installation must be in accordance with the applicable provisions of NFPA 13, NFPA 24, NFPA 37, NFPA 72 and publications referenced therein Locate sprinklers in a consistent pattern with ceiling grid, lights, and air supply diffusers. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage. Locate fire sprinklers around Generators in accordance with NFPA 37.

a. Piping offsets, fittings, and other accessories required must be furnished to provide a complete installation and to eliminate interference with other construction.

b. Wherever the contractor's work interconnects with work of other trades the Contractor must coordinate with other Contractors to insure all Contractors have the information necessary so that they may properly install all necessary connections and equipment. Identify all work items needing access (dampers and similar equipment) concealed above hung ceilings by permanent color coded pins/tabs in the ceiling directly below the item.

c. Provide required supports and hangers for piping, conduit, and equipment so that loading will not exceed allowable loadings of structure. Submittal of a bid must be a deemed representation that the contractor submitting such bid has ascertained allowable loadings and has included in his estimates the costs associated in furnishing required supports.

3.2.1 Waste Removal

At the conclusion of each day's work, clean up and stockpile on site all waste, debris, and trash which may have accumulated during the day as a result of work by the contractor and of his presence on the job. Sidewalks and streets adjoining the property must be kept broom clean and free of waste, debris, trash and obstructions caused by work of the contractor, which will affect the condition and safety of streets, walks, utilities, and property.

3.3 UNDERGROUND PIPING INSTALLATION

The fire protection water main must be laid, and joints anchored, in accordance with NFPA 24. Minimum depth of cover must be 6 feet or the frost line, whichever is deeper. The supply line must terminate inside the building with a flanged piece, the bottom of which must be set not less than 1-foot above the finished floor. A blind flange must be installed temporarily on top of the flanged piece to prevent the entrance of foreign matter into the supply line. A concrete thrust block must be provided at the elbow where the pipe turns up toward the floor. In addition, joints must be anchored in accordance with NFPA 24. Buried steel components must be provided with a corrosion protective coating in accordance with AWWA C203. Piping more than 5 feet outside the building walls must meet the requirements of Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

3.4 ABOVEGROUND PIPING INSTALLATION

The methods of fabrication and installation of the aboveground piping must fully comply with the requirements and recommended practices of NFPA 13 and this specification section.

3.4.1 Protection of Piping Against Earthquake Damage

Seismic restraint is required. Building is classified as an Occupancy Group IV and as such the Seismic Design Category D. Refer to UFC 3-301-01.

3.4.2 Piping in Exposed Areas

Install exposed piping without diminishing exit access widths, corridors or equipment access. Exposed horizontal piping, including drain piping, must be installed to provide maximum headroom.

3.4.3 Piping in Finished Areas

In areas with suspended or dropped ceilings and in areas with concealed spaces above the ceiling, piping must be concealed above ceilings. Piping must be inspected, hydrostatically tested and approved before being concealed. Risers and similar vertical runs of piping in finished areas must be concealed.

3.4.4 Pendent Sprinklers

a. Drop nipples to pendent sprinklers must consist of minimum 1-inch pipe with a reducing coupling into which the sprinkler must be threaded.

b. Where sprinklers are installed below suspended or dropped ceilings, drop nipples must be cut such that sprinkler ceiling plates or escutcheons are of a uniform depth throughout the finished space. The outlet of the reducing coupling must not extend below the underside of the ceiling.

c. Recessed pendent sprinklers must be installed such that the distance from the sprinkler deflector to the underside of the ceiling must not exceed the manufacturer's listed range and must be of uniform depth throughout the finished area.

d. Pendent sprinklers in suspended ceilings must be located in the center

of the tile (+/- 2 inches).

e. Dry pendent sprinkler assemblies must be such that sprinkler ceiling plates or escutcheons are of the uniform depth throughout the finished space.

f. Dry pendent sprinklers must be of the required length to permit the sprinkler to be threaded directly into a branch line tee.

g. Where the maximum static or flowing pressure, whichever is greater at the sprinkler, applied other than through the fire department connection, exceeds 100 psi and a branch line above the ceiling supplies sprinklers in a pendent position below the ceiling, the cumulative horizontal length of an unsupported armover to a sprinkler or sprinkler drop must not exceed 12 inches for steel pipe

h. Sprinklers installed in the pendent position must be of the listed dry pendent type or on return bends, unless otherwise indicated.

3.4.5 Upright Sprinklers

Riser nipples or "sprigs" to upright sprinklers must contain no fittings between the branch line tee and the reducing coupling at the sprinkler.

3.4.6 Pipe Joints

Pipe joints must conform to NFPA 13, except as modified herein. Not more than four threads must show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints must be provided where indicated or required by NFPA 13. Grooved pipe and fittings must be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings, fittings and grooving tools must be products of the same manufacturer. For copper tubing, pipe and groove dimensions must comply with the tolerances specified by the coupling manufacturer. The diameter of grooves made in the field must be measured using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Groove width and dimension of groove from end of pipe must be measured and recorded for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances.

3.4.7 Reducers

Reductions in pipe sizes must be made with one-piece tapered reducing fittings. When standard fittings of the required size are not manufactured, single bushings of the face or hex type will be permitted. Where used, face bushings must be installed with the outer face flush with the face of the fitting opening being reduced. Bushings cannot be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2-inch.

3.4.8 Pipe Penetrations

a. Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors must be core-drilled and provided

with pipe sleeves. Each sleeve must be Schedule 40 galvanized steel, ductile-iron or cast-iron pipe and extend through its respective wall or floor and be cut flush with each wall surface. Sleeves must provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe must be firmly packed with mineral wool insulation.

b. Where pipes and sleeves penetrate fire walls, fire partitions, or floors, pipes/sleeves must be firestopped in accordance with Section 07 84 00 FIRESTOPPING.

c. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe must be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

d. All penetrations through the boundary of rooms/areas identified as secure space area must meet ICS 705-1.

3.4.9 Escutcheons

Escutcheons must be provided for pipe penetration in finished areas of ceilings, floors and walls. Escutcheons must be securely fastened to the pipe at surfaces through which piping passes.

3.4.10 Inspector's Test Connection

Unless otherwise indicated, the test connection must consist of 1-inch pipe connected to the remote branch line; a test valve located approximately 7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test". All test connection piping must be inside of the building and penetrate the exterior wall at the location of the discharge orifice only. The discharge orifice must be located outside the building wall no more than 2 feet above finished grade, directed so as not to cause damage to adjacent construction or landscaping during full flow discharge, or to the sanitary sewer. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building. Do not discharge to the roof. Discharge to floor drains, janitor sinks or similar fixtures is not permitted.

Provide concrete splash blocks at all drain and inspector's test connection discharge locations if not discharging to a concrete surface. Splash blocks must be large enough to mitigate erosion and not become dislodged during a full flow of the drain. Ensure all discharged water drains away from the facility and does not cause property damage.

3.4.11 Backflow Preventer

Locate within the building .

Install backflow preventers so that the bottom of the assembly is a minimum of 6 inches above the finished floor/grade. Install horizontal backflow preventers so that the bottom of the assembly is no greater than 24 inches above the finished floor/grade. Install vertical backflow preventers so that the upper operating handwheel is no more than 6 feet above the finished floor/grade. Clearance around control valve handles

must be minimum 6inches above grade/finished floor and away from walls.

3.4.11.1 Test Connection

Provide downstream of the backflow prevention assembly UL 668 hose valves with 2.5-inch National Standard male hose threads with cap and chain. Provide one valve for each 250 gpm of system demand or fraction thereof. Provide a permanent sign in accordance with paragraph entitled "Identification Signs" which reads, "Test Valve". Indicate location of test header. If an exterior connection, provide a control valve inside a heated mechanical room to prevent freezing. The piping between the backflow preventer test header control valve and the exterior test header must be provided with an automatic drip arranged to drain to the outside.

3.4.12 Drains

a. Main drain piping must be provided to discharge at a safe point outside the building, no more than 2 feet above finished grade. Provide a concrete splash block at drain outlet. Discharge to the exterior must not interfere with exiting from the facility. Water discharge or runoff must not cross the path of egress from the building.

b. Auxiliary drains must be provided as required by NFPA 13. Auxiliary drains are permitted to discharge to a floor drain if the drain is sized to accommodate full flow (min 40 gpm). Discharge to service sinks or similar plumbing fixtures is not permitted.

3.4.13 Installation of Fire Department Connection

Connection must be mounted on the exterior wall approximately 3 feet above finished grade. The piping between the connection and the check valve must be provided with an automatic drip in accordance with NFPA 13 and piped to drain to the outside or a floor drain within the same room.

3.4.14 Identification Signs

Signs must be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Main drain test results must be etched into main drain identification sign. Hydraulic design data must be etched into the nameplates and permanently affixed to each sprinkler riser as specified in NFPA 13. Provide labeling on the surfaces of all feed and cross mains to show the pipe function (e.g., "Sprinkler System", "Fire Department Connection", "Standpipe") and normal valve position (e.g. "Normally Open", "Normally Closed"). For pipe sizes 4-inch and larger provide white painted stenciled letters and arrows, a minimum of 2 inches in height and visible from at least two sides when viewed from the floor. For pipe sizes less than 4-inch, provide white painted stenciled letters and arrows, a minimum of 0.75-inch in height and visible from the floor.

3.4.15 Isolation Valve

Provide a control valve on the riser assembly, downstream of the backflow preventer test connection and waterflow indicator, to allow isolation of riser when testing (tripping) the automatic water control valve without allowing water to enter the system piping. The control valve must be electrically supervised in the open position.

3.5 ELECTRICAL

Except as modified herein, electric equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Alarm signal wiring connected to the building fire alarm control system must be by the fire alarm installer.

3.5.1 Overcurrent and Surge Protection

All equipment connected to alternating current circuits must be protected from surges. Cables and conductors that serve as communications links, except fiber optics, must have surge protection circuits installed at each end. Fuses must not be used for surge protection.

3.5.2 Grounding

Grounding must be provided to building ground.

3.5.3 System Field Wiring

3.5.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and professional manner and installed parallel with or at right angles to the sides and back of the box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in an enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the RSCP and remote RSCP, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.5.3.2 Terminal Cabinets

Provide a terminal cabinet at the base of the circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "RELEASING SYSTEM TERMINAL CABINET" with 2-inch lettering, on the front of the terminal cabinet.

3.5.3.3 Alarm Wiring

a. Voltages must not be mixed in junction boxes, housing or device,

except those containing power supplies and control relays.

b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the RSCP.

c. Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. T-tapping using screw terminal blocks is allowed for Class "B" .

d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the Designated Fire Protection Engineer (DFPE).

3.5.3.4 Back Boxes and Conduit

See Section 28 31 70 for requirements.

a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.

b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.

c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.

d. Flexible metal conduit is permitted for initiating device circuits 6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use liquid tight flexible metal conduit in damp and wet locations.

e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.

f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

3.5.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, and RSCP

must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet and RSCP must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12-point lettering minimum size, and mounted within each cabinet, panel, or control unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.6 RELEASING CONTROL SYSTEM

3.6.1 Releasing Service Fire Alarm Control Panel (RSCP)

The RSCP must be located in a year round environmentally conditioned space and not in the hazard area served but adjacent to it. Locate the RSCP where indicated on the drawings. Surface mount the enclosure with the top of the cabinet 6 feet above the finished floor or center the cabinet at 5 feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the RSCP.

3.6.2 Manual Stations

See Section 28 31 70 for requirements.

3.6.3 Graphic Annunciator

Locate the graphic annunciator as shown on the drawings. Mount the panel, with the top of the panel 6 feet above the finished floor or center the panel at 5 feet, whichever is lower.

3.6.4 Remote LCD Annunciator

Locate the remote LCD annunciator as shown on the drawings. Mount the panel, with the top of the panel 6 feet above the finished floor or center the panel at 5 feet, whichever is lower.

3.6.5 Ceiling Bridges

See Section 28 31 70 for requirements.

3.7 PAINTING

Color code mark piping red

a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving releasing system equipment), releasing system conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

b. In finished areas, paint exposed electrical conduit (serving releasing system equipment), releasing system conduit, surface metal raceways, junction boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Releasing System" and the conduit must have painted red bands 3/4-inch wide at 10-foot centers and at each side of a floor, wall, or ceiling penetration.

3.8 FIELD QUALITY CONTROL

3.8.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level IV Fire Sprinkler Technician, and the representative of the installing company, and reviewed by the QFPE 60 days prior to performing system tests. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, control devices/equipment, batteries, power sources/supply, annunciators, special hazard equipment, and interface equipment. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forms in NFPA 13 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government final testing.

a. Identify the NFPA Class of all initiating device circuits (IDC) and signaling line circuits (SLC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for smoke detector testing). The use of magnets is not permitted.

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.8.2 Pre-Government Testing

3.8.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that equipment is functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" and "System Acceptance" as noted in NFPA 13 and NFPA 72. The Contractor and QFPE must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 13 and the test reports noted below.

a. NFPA 13 Aboveground Material and Test Certificate

b. NFPA 13 Underground Material and Test Certificate

c. NFPA 72 Record of Completion

d. NFPA 72 Record of Inspection and Testing

3.8.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the Contracting Officers Designated Representative (COR). Government final testing will not be scheduled until the COR has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation fire alarm reporting system have been completed and tested to confirm communications are fully functional. Submit request for test at least 15 calendar days prior to the requested test date.

3.8.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.8.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. The contractor's Qualified Fire Protection Engineer (QFPE).

c. Marked-up red line drawings of the system as actually installed.

d. Loop resistance test results.

e. Complete program printout including input/output addresses.

f. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

Government Final Tests will be witnessed by the Contracting Officer, and Qualified Fire Protection Engineer (QFPE). At this time, all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.9 MINIMUM SYSTEM TESTS

The system, including the underground water mains, and the aboveground piping and system components, must be tested to ensure that equipment and components function as intended. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure must be tested in accordance with NFPA 13 and NFPA 24.

3.9.1 Underground Piping

3.9.1.1 Flushing

Underground piping must be flushed in accordance with NFPA 24.

3.9.1.2 Hydrostatic Test

New underground piping must be hydrostatically tested in accordance with NFPA 24.

3.9.2 Aboveground Piping

3.9.2.1 Hydrostatic Test

Aboveground piping must be hydrostatically tested in accordance with NFPA 13. There must be no drop in gauge pressure or visible leakage when the system is subjected to the hydrostatic test. The test pressure must be read from a gauge located at the low elevation point of the system or portion being tested.

3.9.2.2 Air Pressure Test

As specified in NFPA 13, an air pressure leakage test at 50 psi must be conducted for 24 hours. There must be no drop in gauge pressure in excess of 1.5 psi for the 24 hours. This air pressure test is in addition to the required hydrostatic test.

3.9.2.3 Backflow Prevention Assembly Forward Flow Test

Each backflow prevention assembly must be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor must provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5-inch diameter hoses, playpipe nozzles or flow diffusers, calibrated pressure gauges, and pitot tube gauge. The Contractor must provide all necessary supports to safely secure hoses and nozzles during the test. At the system demand flow, the pressure readings and pressure drop (friction loss) across the assembly must be recorded. A metal placard must be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate determined during the preliminary testing. The pressure drop must be compared to the manufacturer's data and the readings observed during the final inspections and tests.

3.9.3 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

a. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the preliminary test with results available at the final system test.

c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

d. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

e. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

f. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

g. Determine that the system is operable under trouble conditions as specified.

h. Visually inspect wiring.

i. Test the battery charger and batteries.

j. Verify that software control and data files have been entered or programmed into the releasing control unit. Hard copy records of the software must be provided to the Contracting Officer.

k. Verify that red-line drawings are accurate.

l. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

m. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

n. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must be conducted using real smoke or the use of canned smoke which is permitted.

o. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

p. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.9.4 Alarm Device Test

Each alarm switch/device must be tested by flowing water through the inspector's test connection.

3.9.5 Main Drain Flow Test

Following flushing of the underground piping, a main drain test must be

made to verify the adequacy of the water supply. Static and residual pressures must be recorded on the certificate specified in paragraph SUBMITTALS.

3.9.6 Automatic Water Control Valves Trip Test

Each water control valve must be independently trip-tested in accordance with the manufacturer's published instructions. Each valve must be electrically trip-tested by actuating a respective heat detector, a manual actuation station connected to the system control unit and the manual release which is part of the valve trim. Each valve must be returned to normal condition after each test. Prior to trip testing sprinkler deluge system, precautionary steps must be taken to prevent water damage to the building and equipment from sprinkler discharge. Water delivery times must be measured starting at the normal nitrogen pressure on the system. Control valves on preaction systems must remain open until piping is filled with water.

3.9.7 Supervisory Nitrogen System Test

System supervisory nitrogen pressure must be reduced from the normal system pressure to the point at which a low-pressure alarm is sounded. Nitrogen pressure must be restored to verify trouble signal restoration. Automatic start/stop features of nitrogen generator must be tested.

3.10 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the final acceptance test.

a. Provide one set of full size paper as-built drawings and schematics. The drawings must be prepared electronically and sized no less than the contract drawings. Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of AutoCAD, DXF and portable document formats of as-built drawings and schematics.

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

d. Provide operating and maintenance (O&M) instructions.

3.11 ONSITE TRAINING

Conduct a training course for the responding fire department and operating and maintenance personnel as designated by the Contracting Officer. Training must be performed on two separate days (to accommodate different shifts of Fire Department personnel) for a period of 12 hours of normal working time and must start after the system is functionally complete and after the final acceptance test. The on-site training must cover all of the items contained in the approved Operating and Maintenance Instructions.

3.12 EXTRA MATERIALS

3.12.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturers. Installing fire alarm contractor is NOT responsible for damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.12.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed systems. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the final acceptance testing and must be accompanied by an inventory list.

3.12.3 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

a. As-built shop drawings

b. Product data sheets

c. Design calculations

d. Site-specific software data package

e. All documentation required by SD-06

-- End of Section --

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SECTION 21 30 00

FIRE PUMPS

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SECTION 21 30 00

FIRE PUMPS
04/08, CHG 1: 08/13

PART 1 GENERAL

1.1 SUMMARY

Except as modified in this Section or on the drawings, install fire pumps in conformance with NFPA 20, NFPA 70, NFPA 72, and UFC 3-600-01. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification governs. Devices and equipment for fire protection service must be UL Fire Prot Dir listed or FM APP GUIDE approved. Interpret all reference to the authority having jurisdiction to mean the Contracting Officer.

1.2 SEQUENCING

1.2.1 Primary Fire Pump

Provide primary fire pump that automatically operates when the pressure drops to 65 psi,automatically upon tripping of the sprinkler systems, and manually when the starter is operated. Provide pump that continue to run until shut down manually. The fire pump must automatically stop operating when the system pressure reaches 125 psi and after the fire pump has operated for the minimum pump run time specified herein.

1.2.2 Secondary Fire Pump

Operate secondary fire pump at 10 psi increments, set below the primary fire pump starting pressure. The fire pump must automatically stop running at 125psi and after the fire pump has operated for the minimum pump run time. Prevent fire pumps from starting simultaneously and start sequentially at intervals of 5 to 10 seconds.

1.2.3 Pressure Maintenance Pump

Operate pressure maintenance pump when the system pressure drops to 65psi. Stop pump automatically when the system pressure reaches 85 psi and after the pump has operated for the minimum pump run time specified herein.

1.3 FIRE PUMP INSTALLATION RELATED SUBMITTALS

The Fire Protection Specialist must prepare a list of the submittals, from the Contract Submittal Register, that relate to the successful installation of the fire pump(s), no later than 7 days after the approval of the Fire Protection Specialist and the Manufacturer's Representative. Include a letter of approval signed and dated by the Fire Protection Specialist with the submittals identified on this list when submitted to the Government.

1.4 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Where publications or references are listed

without a date, use the most recent editions.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.1	(2022) Power Piping

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2018) Hypochlorites
AWWA B301	(2018) Liquid Chlorine
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C606	(2022) Grooved and Shouldered Joints

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard

	Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A795/A795M	(2021) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B135/B135M	(2017) Standard Specification for Seamless Brass Tube
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F436	(2011) Hardened Steel Washers

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalg

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 20	(2022) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 37	(2024) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 1963	(2019) Standard for Fire Hose Connections

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2012) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 1-200-01	DoD Building Code
UFC 3-600-01	(2016; with Change 6, 2021) Fire Protection Engineering for Facilities
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

UL SOLUTIONS (UL)

UL 80	(2007; Reprint Jan 2014) Standard for Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids
UL 142	(2006; Reprint Jan 2021) UL Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 262	(2004; Reprint Jul 2023) Gate Valves for Fire-Protection Service
UL 448	(2020) UL Standard for Safety Centrifugal Stationary Pumps for Fire-Protection Service

UL 1247	(2007; Reprint Jun 2020) Diesel Engines for Driving Stationary Fire Pumps
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.5 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Fire Pump Installation Related Submittals

Fire Protection Specialist; G, DO

No later than 14 days after the Notice to Proceed and prior to the submittal of the fire pump installation drawings

SD-02 Shop Drawings

Installation Drawings; G, DO

4 copies

As-Built Drawings; G, RO

Piping Layout; G, DO

Pump Room; G,DO

SD-03 Product Data

Catalog Data; G, DO

Spare Parts

Preliminary Tests

At least 14 days prior to the proposed date and time to begin Preliminary Tests

Field Tests; G, RO

At least 2 weeks before starting field tests

Manufacturer's Representative; G, RO

Field Training; G, RO

SD-06 Test Reports

Preliminary Tests

4 copies of the completed Preliminary Tests Reports, no later that 7 days after the completion of the Preliminary Tests.

SD-07 Certificates

Fire Protection Specialist

No later than 14 days after the Notice to Proceed and prior to the submittal of the fire pump installation drawings

Qualifications of Welders

Qualifications of Installer

Preliminary Test Certification

Final Test Certification

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G, RO

At least 14 days prior to conducting field training

Flow Meter

Submit Data Package 2 for flow meter and controllers in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.6 EXTRA MATERIALS

Submit Spare Parts data for each different item of equipment and material specified. Include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied by the Contractor.

1.7 QUALITY ASSURANCE

1.7.1 Fire Protection Specialist

Perform work specified in this section under the supervision of and certified by the Fire Protection Specialist. Submit the name and documentation of certification of the proposed Fire Protection Specialists. The Fire Protection Specialist is an individual who is a registered professional engineer and a Full Member of the Society of Fire Protection Engineers or who is certified as a Level IV Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. Engage the Fire Protection Specialist regularly in the design and installation of the type and complexity of system specified in the Contract documents. The specialist is an individual who has served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.7.2 Qualifications of Welders

Submit certificates of each welder's qualifications prior to site welding; certifications more than one year old are not acceptable.

1.7.3 Qualifications of Installer

Prior to installation, submit data for approval showing that the Contractor has successfully installed fire pumps and associated equipment of the same type and design as specified herein, or that he has a firm contractual agreement with a subcontractor having such required experience. Include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 18 months.

1.7.4 Preliminary Test Certification

When preliminary tests have been completed and corrections made, submit a signed and dated certificate with a request for a formal inspection and tests.

1.7.5 Final Test Certification

Concurrent with the Final Acceptance Test Report, submit certification by the Fire Protection Specialist that the fire pump installation is in accordance with the contract requirements, including signed approval of the Preliminary and Final Acceptance Test Reports. Submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings.

1.7.6 Manufacturer's Representative

Perform work specified in this section under the supervision of and certified by a representative of the fire pump manufacturer. Submit the name and documentation of certification of the proposed Manufacturer's Representative, concurrent with submittal of the Fire Protection Specialist Qualifications. Engage the Manufacturer's Representative regularly in the installation of the type and complexity of fire pump(s)

specified in the Contract documents. The representative is an individual who has served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

1.8 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, excessive humidity and temperature variations, dirt and dust, or other contaminants. Additionally, either cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

a. Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicates items that have been in satisfactory use for at least 2 years prior to bid opening.

b. Submit manufacturer's catalog data included with the Fire Pump Installation Drawings for each separate piece of equipment proposed for use in the system. Indicate the name of the manufacturer of each item of equipment, with data annotated to indicate model to be provided. In addition, provide a complete equipment list that includes equipment description, model number and quantity. Catalog data for material and equipment includes, but is not limited to, the following:

(1) Fire pumps, drivers and controllers including manufacturer's certified shop test characteristic curve for each pump. Shop test curve may be submitted after approval of catalog data but must be submitted prior to the final tests.

(2) Pressure maintenance pump and controller.

(3) Piping components.

(4) Valves, including gate, check, globe and relief valves.

(5) Gauges.

(6) Hose valve manifold test header and hose valves.

(7) Flow meter.

(8) Restrictive orifice union.

(9) Associated devices and equipment.

c. Provide a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, capacity or size and system in which installed and system which it controls and catalog number for all equipment. Affix standard nameplates securely in a conspicuous place and easy to read to pumps and motors. Provide nameplates and markings in accordance with UL 448. Provide nameplate and markings in accordance with UL 1247 for diesel driver. Provide electric motor nameplates with the minimum information required by NFPA 70, Section 430-7.

2.2 FIRE PUMP

Provide both secondary electric motor driven and primary diesel engine driven fire pump. Facility requires redundant pumps due to its Class IV status. Provide each pump with a capacity rated at 750 gpm with a rated net pressure of 40 psi. Furnish no less than 150 percent of rated flow capacity at not less than 65 percent of rated net pressure. Provide horizontal split casefire pumps. Equip horizontal pumps with automatic air release devices. Use maximum rated pump speed of 1750 rpm when driving each pump at rated capacity. Provide pumps that are automatic start and manual stop. Provide pumps conforming to the requirements of UL 448. Ensure fire pump discharge and suction gauges are oil-filled type. Pumps are in parallel configuration.

2.3 REQUIREMENTS FOR FIRE PROTECTION SERVICE

2.3.1 General Requirements

Provide Materials and Equipment that have been tested by Underwriters Laboratories, Inc. and are listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, such means listed in UL Fire Prot Dir or FM APP GUIDE.

2.3.2 Alarms

Provide audible and visual alarms as required by NFPA 20 on the controller. Provide remote supervision as required by NFPA 20, in accordance with NFPA 72. Provide remote alarm devices located at the Readiness Room. Activate alarm signal upon the following conditions: electric motor controller has operated into a pump running condition, loss of electrical power to electric motor starter, and phase reversal on line side of motor starter, engine drive controller has operated into an engine running condition, engine drive controller main switch has been turned to OFF or to MANUAL position, trouble on engine driven controller or engine. Provide weatherproof exterior alarm devices. Provide alarm silencing switch and red signal lamp, with signal lamp arranged to come on when switch is placed in OFF position.

2.4 UNDERGROUND PIPING COMPONENTS

2.4.1 Pipe and Fittings

Provide outside-coated, cement mortar-lined, ductile-iron pipe with a rated working pressure of 175 psi conforming to NFPA 24 for piping under the building and less than 5 feet outside of the building walls. Anchor the joints in accordance with NFPA 24; provide concrete thrust block at the elbow where the pipe turns up toward the floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. Provide minimum pipe size of 8 inches. Refer to Civil Plans. Provide minimum cover depth as required by NFPA 24, but no less than 6 feet. Piping more than 5 feet outside of the building walls must be cement mortar-lined, AWWA C151/A21.51 ductile-iron pipe, and AWWA C110/A21.10 fittings conforming to NFPA 24. Refer to Section 33 11 00 WATER UTILITY DISTRIBUTION PIPING.

2.4.2 Fittings and Gaskets

Provide ductile iron fittings conforming to AWWA C110/A21.10. Provide

gaskets that are suitable in design and size for the pipe with which such gaskets are to be used. Provide gaskets for ductile iron pipe joints conforming to AWWA C111/A21.11.

2.4.3 Valves and Valve Boxes

Provide gate valves conforming to AWWA C500 or UL 262. Provide valves with cast-iron body and bronze trim and that open by counterclockwise rotation. Provide exterior valve as a post indicator type.

2.4.4 Gate Valve and Indicator Posts

Provide inside screw type gate valves for underground installation with counterclockwise rotation to open. Where indicating type valves are shown or required, use indicating valves consisting of gate valves with an approved indicator post of a length to permit the top of the post to be located 3 feet above finished grade. Provide gate valves and indicator posts with one coat of primer and two coats of red enamel paint and that are listed in UL Fire Prot Dir or FM APP GUIDE.

2.4.5 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping for all buried piping. Ensure tape is detectable by an electronic detection instrument. Provide tape in rolls, 3 inches minimum width, color-coded for the utility involved and imprinted in bold black letters continuously and repeatedly over the entire tape length. Warning and identification must be "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and lettering that is unaffected by moisture and other substances contained in the trench backfill material. Bury tape at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavement.

2.5 ABOVEGROUND PIPING COMPONENTS

2.5.1 Pipe Sizes 2.5 inches and Larger

2.5.1.1 Pipe

Provide piping consisting of ASTM A53/A53M, Schedule 40 (except for Schedule 30 for pipe sizes 8 inchesand greater in diameter), Type E or Type S, Grade A; black steel pipe. Join steel pipe by means of flanges welded to the pipe or mechanical grooved joints only. Do not join piping by welding or weld fittings. Galvanize suction piping on the inside in accordance with NFPA 20.

2.5.1.2 Grooved Mechanical Joints and Fittings

Provide joints and fittings that are designed for no less than 175 psi service and are the product of the same manufacturer. Provide malleable iron fitting and coupling houses conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12. Provide flush type gasket that fills the entire cavity between the fitting and the pipe. Provide cadmium plated or zinc electroplated, heat-treated steel nuts and bolts conforming to ASTM A183.

2.5.1.3 Flanges

Provide ASME B16.5, Class 150 flanges. Provide flanges at valves, connections to equipment, and where indicated.

2.5.1.4 Gaskets

Provide AWWA C111/A21.11, cloth inserted red rubber gaskets.

2.5.1.5 Bolts

Provide ASTM A193/A193M, Grade B7 bolts. Do not extend bolts less than three full threads beyond the nut with bolts tightened to the required torque.

2.5.1.6 Nuts

Provide ASTM A194/A194M, Grade 7 nuts.

2.5.1.7 Washers

Provide washers meeting the requirements of ASTM F436. Provide flat circular washers under all bolt heads and nuts.

2.5.2 Piping Sizes 2 inches and Smaller

2.5.2.1 Steel Pipe

Provide ASTM A795/A795M, Schedule 40, Type E or Type S, Grade A steel pipe with threaded end connections. Provide ASME B16.3 Class 150, threaded fittings. Provide ASME B16.39, Class 150, unions.

2.5.3 Pipe Hangers and Supports

Provide adjustable hangers and supports that are UL listed UL Fire Prot Dir or FM approved FM APP GUIDE. Finish of rods, nuts, washers, hangers, and supports must be zinc-plated after fabrication.

2.5.4 Valves

Provide valves that are UL listed UL Fire Prot Dir or FM approved FM APP GUIDE for fire protection service and with flange or threaded end connections.

2.5.4.1 Gate Valves and Control Valves

Provide outside screw and yoke (O.S.&Y.) type gate valves and control valves which open by counterclockwise rotation. Butterfly-type control valves are not permitted.

2.5.4.2 Tamper Switch

Equip the suction control valves, the discharge control valves, valves to test header and flow meter, and the by-pass control valves with valve tamper switches for monitoring by the fire alarm system.

2.5.4.3 Check Valve

Check valve must be clear open, swing type check valve with flange or

threaded inspection plate.

2.5.4.4 Relief Valve

Provide spring operated type relief valve conforming to NFPA 20. Provide a means of detecting water motion in the relief lines where the discharge is not visible within the pump house.

2.5.4.5 Circulating Relief Valve

Provide an adjustable circulating relief valve for each fire pump in accordance with NFPA 20.

2.5.4.6 Suction Pressure Regulating Valve

Provide suction pressure regulating valve that is FM approved FM APP GUIDE. Monitor suction pressure through a pressure line to the controlling mechanism of the regulating valve. Arrange valve in accordance with the manufacturer's recommendations.

2.5.5 Hose Valve Manifold Test Header

Construct header of steel pipe. Provide ASME B16.5, Class 150 flanged inlet connection to hose valve manifold assembly. Provide approved bronze hose gate valve with 2.5 inch National Standard male hose threads with cap and chain; locate 3 feet above grade in the horizontal position for each test header outlet. Ensure welding is metallic arc process in accordance with ASME B31.1.

2.5.6 Pipe Sleeves

Provide a pipe sleeve at each location where piping passes entirely through walls, ceilings, roofs, and floors, including pipe entering buildings from the exterior. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, and floors. Provide one inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of the sleeve or core-drilled hole with plastic waterproof cement which will dry to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, provide a fire seal between the pipe and the sleeve in accordance with Section 07 84 00 FIRESTOPPING.

a. Sleeves in Masonry and Concrete Walls, Ceilings, Roofs, and Floors: Provide hot-dip galvanized steel, ductile-iron, or cast-iron pipe sleeves. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves provided that cavities in the core-drilled hole be completely grouted smooth.

b. Sleeves in Other Than Masonry and Concrete Walls, Ceilings, Roofs, and Floors: Provide galvanized steel sheet pipe not less than 0.90 psf.

2.5.7 Escutcheon Plates

Provide one-piece or split-hinge metal plates for piping entering floors, walls, and ceilings in exposed areas. Provide polished stainless steel or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on plates in unfinished spaces. Secure plates in place.

2.6 DISINFECTING MATERIALS

2.6.1 Liquid Chlorine

Provide liquid chlorine conforming to AWWA B301.

2.6.2 Hypochlorites

Provide calcium hypochlorite and sodium hypochlorite conforming to AWWA B300.

2.7 ELECTRIC MOTOR DRIVER

Provide motors, controllers, contactors, and disconnects with their respective pieces of equipment, as specified herein and provide electrical connections under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide controllers and contactors with a maximum of 120-volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, include the cost of providing additional electrical service and related work under this section. Provide motor conforming to NEMA MG 1 Design B type. Provide premium efficiency type integral size motors in accordance with NEMA MG 1. Provide motor horsepower of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characteristic curve. The motor and fire pump controller must be fully compatible.

2.8 DIESEL ENGINE DRIVER

Provide diesel engine driver conforming to the requirements of UL 1247 which is UL listed UL Fire Prot Dir or FM approved FM APP GUIDE for fire pump service. Driver must be of the make recommended by the pump manufacturer. The engine must be closed circuit, liquid-cooled with radiator and engine-driven fan. Diesel engine must be electric start type taking current from 2 battery units. Equip engine with a fuel in-line filter-water separator. Monitor engine conditions with engine instrumentation panel that has a tachometer, hour meter, fuel pressure gauge, lubricating oil pressure gauge, water temperature gauge, and ammeter gauge. Connect engine to horizontal-shaft pump by flexible couplings. For connections to vertical-shaft fire pumps, use right-angle gear drives and universal joints. Provide an engine jacket water heater to maintain a temperature of 120 degrees F in accordance with NFPA 20.

2.8.1 Engine Capacity

Provide engine with adequate horsepower to drive the pump at all conditions of speed and load over the full range of the pump performance curve. Provide horsepower rating of the engine driver as recommended by the pump manufacturer and derate for temperature and elevation in accordance with NFPA 20. Provide ambient temperature at the pump location of 80 degrees F. Site elevation must be 5,663 feet above mean sea level (MSL).

2.8.2 Exhaust System External to Engine

Provide exhaust system complying with the requirements of NFPA 20 and NFPA 37. Provide an exhaust muffler for each diesel engine driver to reduce noise levels less than 95 dBA. Provide a flexible connector with

flange connections at the engine. Use stainless steel flexible sections suitable for diesel-engines exhaust gas at 1000 degrees F.

2.8.2.1 Steel Pipe and Fittings

ASTM A53/A53M, Schedule 40, black steel, welding end connections. Provide ASME B16.9 or ASME B16.11 welding fittings of the same material and weight as the piping.

2.8.2.2 Flanges

ASME B16.5, Class 150. Provide flanges at connections to diesel engines, exhaust mufflers, and flexible connections. Provide gaskets that are ASME B16.21, composition ring, 0.0625 inch. Provide ASTM A193/A193M, Grade B7 bolts and ASTM A194/A194M, Grade 7 nuts.

2.8.2.3 Piping Insulation

Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING. Products containing asbestos will not be permitted. Insulate exhaust piping system including the muffler with ASTM C533 calcium silicate insulation, minimum of 3 inches. Secure insulation with no less than 0.375 inch width fibrous glass reinforced waterproof tape or Type 304 stainless steel bands spaced no more than 8 inches on center. Provide an aluminum jacket encasing the insulation. Provide aluminum jacket with a minimum thickness of 0.016 inches, a factory-applied polyethylene and kraft paper moisture barrier on the inside surface. Secure the jacket with no less than 0.5 inch wide stainless steel bands, spaced no less than 8 inches on centers. Lap longitudinal and circumferential seams of the jacket no less than 3 inches. Install jackets on horizontal line so that the longitudinal seams are on the bottom side of the pipe. Place the seams of the jacket for the vertical lines on the off-weather side of the pipe. On vertical lines, overlap the circumferential seams of the jacket so the lower edge of each jacket overlaps the upper edge of the jacket below.

2.9 FIRE PUMP CONTROLLERS

Provide automatic type controllers which are UL listed UL Fire Prot Dir or FM approved FM APP GUIDE for fire pump service. Arrange pumps for automatic start and stop, and manual push-button stop. Accomplish automatic stopping only after all starting causes have returned to normal and after a minimum pump run time has elapsed. Provide controllers that are completely terminally wired, ready for field connections, and mounted in a NEMA Type 2 drip-proof enclosure arranged so that controller current carrying parts will not be less than 12 inches above the floor. Provide controllers with voltage surge arresters installed in accordance with NFPA 20. Equip controllers with a bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments, automatic starting relay actuated from normally closed contacts, visual alarm lamps and supervisory power light. Equip controllers with a thermostat switch with adjustable setting to monitor the pump room temperature and to provide an alarm when temperatures falls below 40 degrees F Equip controllers with a sequential start timer/relay feature to start multiple fire pumps in sequence.

2.9.1 Controller for Electric Motor Driven Fire Pump

Controller must be electronic soft start starting type. Design controller

for 25 HP at 460 volts. Provide controller and transfer switch with a short circuit rating of 100,000 amps r.m.s. symmetrical at 460 volts a.c. Provide an automatic transfer switch (ATS) for each fire pump in compliance with NFPA 20 and specifically listed for fire pump service. The ATS must transfer source of power to the alternate source upon loss of normal power. Controller must monitor pump running, loss of a phase or line power, phase reversal and pump room temperature. Display alarms individually in front of panel by lighting of visual lamps. Label each lamp with rigid etched plastic labels. Equip controller with terminals for remote monitoring of pump running, pump power supply trouble (loss of power or phase and phase reversal), and pump room trouble (pump room temperature), and for remote start. Limited service fire pump controllers are not permitted, except for fire pumps driven by electric motors rated less than 15 hp. Equip controller with a 7-day electric pressure recorder with 24-hour spring wound back-up. Provide a readout of the system pressure from 0 to 15 hp, time, and date. Controller must require the pumps to run for ten minutes for pumps with driver motors under 200 horsepower and for 15 minutes for pumps with motors 200 horsepower and greater, prior to automatic shutdown. Equip the controller with an externally operable isolating switch which manually operates the motor circuit. Provide means in the controller for measuring current for all motor circuit conductors.

The combination fire pump controller/transfer switch size identified on the contract drawings is based on prelimminary calculations. Size the combination fire pump controller/transfer switch to match the fire pump size yielded by the performance requirements of this contract's plans and specifications.

2.9.2 Controller for Diesel Engine Driven Fire Pump

Controller must require the pump to run for 30 minutes prior to automatic shutdown. Equip controller with two battery chargers; two ammeters; two voltmeters, one for each set of batteries. Automatically alternate the battery sets for starting the pumps. Equip the controller with the following supervisory alarm functions:

a. Engine Trouble (individually monitored)

(1) Engine overspeed

(2) Low Oil Pressure

(3) High Water Temperature

(4) Engine Failure to Start

(5) Battery

(6) Battery Charger/AC Power Failure

b. Main Switch Mis-set

c. Pump Running

d. Pump Room Trouble (individually monitored)

(1) Low Fuel

(2) Low Pump Room Temperature

(3) Low Reservoir Level

Display alarms individually in front of panel by lighting of visual lamps, except that individual lamps are not required for pump running and main switch mis-set. Equip controller with a 7-day electric pressure recorder with 24-hour back-up mounted inside the controller. Provide a readout of the system pressure from 0 to 300 psi, time, and date. Equip the controller with an audible alarm which will activate upon any engine trouble or pump room trouble alarm condition and alarm silence switch. Equip the controller with terminals for field connection of a remote alarm for main switch mis-set, pump running, engine trouble and pump room trouble; and terminals for remote start. When engine emergency overspeed device operates, the controller must cause the engine to shut down without time delay and lock out until manually reset.

2.10 BATTERIES

Provide sealed lead calcium batteries for diesel engine driver. Mount batteries in a steel rack with non-corrosive, non-conductive base, no less than 12 inches above the floor.

2.11 PRESSURE SENSING LINE

Provide a completely separate pressure sensing line for each fire pump and for the jockey pump. Arrange the sensing line in accordance with Figure A-7-5.2.1. of NFPA 20. Provide sensing line of 1/2 inchH58 brass tubing complying with ASTM B135/B135M. Equip the sensing line with two restrictive orifice unions each. Provide restricted orifice unions consisting of ground-face unions with brass restricted diaphragms drilled for a 3/32 inch. Mount restricted orifice unions in the horizontal position, no less than 5 feet apart on the sensing line. Provide two test connections for each sensing line. Test connections consist of two brass 1/2 inch globe valves and 1/4 inch gauge connection tee arranged in accordance with NFPA 20. Equip one of the test connections with a 0 to 300 psi water oil-filled gauge. Connect sensing line to the pump discharge piping between the discharge piping control valve and the check valve.

2.12 PRESSURE MAINTENANCE PUMP

2.12.1 General

Provide pressure maintenance pump that is electric motor driven, in-line vertical shaft, centrifugal type with a rated discharge of 7.5 gpm at 50 psig. Pump must draft from the suction supply side of the suction pipe gate valve of the fire pump and discharge into the system at the downstream side of the pump discharge gate valve. Provide an approved indicating gate valve of the outside screw and yoke (O.S.&Y.) type in the maintenance pump discharge and suction piping. Provide oil-filled water pressure gauge and approved check valve in the maintenance pump discharge piping. Provide swing type check valve with removable inspection plate.

2.12.2 Pressure Maintenance Pump Controller

Arrange pressure maintenance pump controller for automatic and manual starting and stopping and equip with a "manual-off-automatic" switch. Provide controller which is completely prewired, ready for field connections, and wall-mounted in a NEMA Type 2 drip-proof enclosure.

Equip the controller with a bourdon tube pressure switch or a solid state pressure switch with independent high and low adjustments for automatic starting and stopping. Provide a sensing line connected to the pressure maintenance pump discharge piping between the control valve and the check valve. Provide sensing line conforming to paragraph, PRESSURE SENSING LINE. The sensing line must be completely separate from the fire pump sensing lines. Provide an adjustable run timer to prevent frequent starting and stopping of the pump motor. Set the run timer for 2 minutes.

2.13 DIESEL FUEL SYSTEM EXTERNAL TO ENGINE

Provide fuel system that meets all requirements of NFPA 20 and NFPA 37. Equip fuel tank vent piping with screened weatherproof vent cap. Extend vents to the outside. Equip each tank with a fuel level gauge. Provide flexible bronze or stainless steel piping connectors with single braid at each piping connection to the diesel engine. Use steel piping for supply, return, and fill piping, except supply and return piping may be copper tubing. Protect fuel lines against mechanical damage. Equip fill line with 16 mesh removable wire screen. Extend fill lines to the exterior. Mount a weatherproof tank gauge on the exterior wall near each fill line for each tank. The fill cap must be able to be locked by padlock. Locate the engine supply (suction) connection on the side of the fuel tank so that 5 percent of the tank volume provides a sump volume not useable by the engine. The elevation of the fuel tank must be such that the inlet of the fuel supply line is located so that its opening is no lower than the level of the engine fuel transfer pump. Pitch the bottom of the tank 1/4 inch/foot to the side opposite the suction inlet connection, and to an accessible 1 inch plugged globe drain valve.

2.13.1 Fuel Piping

As specified in NFPA 20.

2.13.2 Diesel Fuel Tanks

UL 80 or UL 142 for aboveground tanks.

2.13.3 Valves

Provide an indicating and lockable ball valve in the supply line adjacent to the tank suction inlet connection. Provide a check valve in fuel return line. Valves mustl be suitable for oil service. Valves must have union end connections or threaded end connections.

2.13.3.1 Globe Valve

MSS SP-80 Class 125

2.13.3.2 Check Valve

MSS SP-80, Class 125, swing check

2.13.3.3 Ball Valve

Full port design, copper alloy body, 2-position lever handle

2.14 JOINTS AND FITTINGS FOR COPPER TUBE

Provide wrought copper and bronze solder-joint pressure fittings

conforming to ASME B16.22 and ASTM B75/B75M. Provide cast copper alloy solder-joint pressure conforming conform to ASME B16.18. Provide cast copper alloy fittings for flared copper tube conforming to ASME B16.26 and ASTM B62. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment. Extracted brazed tee joints produced with an acceptable tool and installed as recommended by the manufacturer may be used. Provide grooved mechanical joints and fittings that are designed for no less than 125 psig service and are the product of the same manufacturer. Provide ductile iron grooved fitting and mechanical coupling housing conforming to ASTM A536. Use gaskets in grooved joints consisting of molded synthetic polymer of pressure responsive design and conforming to ASTM D2000 for circulating medium up to 239 degrees F. Provide grooved joints conforming to AWWA C606 Use steel coupling nuts and bolts in grooved joints conforming to ASTM A183.

2.15 PUMP BASE PLATE AND PAD

Provide a common base plate for each horizontal-shaft fire pump for mounting pump and driver unit. Construct the base plate of cast iron with raised lip tapped for drainage or welded steel shapes with suitable drainage. Provide each base plate for the horizontal fire pumps with a 1 inch galvanized steel drain line piped to the nearest floor drain. For vertical shaft pumps, provide pump head with a cast-iron base plate which serves as the sole plate for mounting the discharge head assembly. Mount pump units and bases on a raised 4 inches reinforced concrete pad that is an integral part of the reinforced concrete floor. Pumps shall be seismically restrained to Class "D".

2.16 HOSE VALVE MANIFOLD TEST HEADER

Connect hose valve test header by ASME B16.5, Class 150 flange inlet connection. Provide UL listed UL Fire Prot Dir or FM approved FM APP GUIDE bronze hose gate valves with 2.5 inches American National Fire Hose Connection Screw Standard Threads (NH) in accordance with NFPA 1963. Provide number of valves in accordance with NFPA 20. Equip each hose valve with a cap and chain, and locate no more than 3 feet and no less than 2 feet above grade.

2.17 FLOW METER

Provide meter that is UL listed UL Fire Prot Dir or FM approved FM APP GUIDE as flow meters for fire pump installation with direct flow readout device. Provide flow meter that is capable of metering any waterflow quantities between 50 percent and 150 percent of the rated flow of the pumps. Arrange piping to permit flow meter to discharge to pump suction and to discharge through test header. The meter throttle valve and the meter control valves must be O.S.&Y. valves. Provide automatic air release if flow meter piping between pump discharge and pump suction forms an inverted "U". Provide venturi type meter.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work. All work shall comply with UFC 1-200-01, and UFC 3-600-01.

3.2 INSPECTION BY FIRE PROTECTION SPECIALIST

Periodically perform a thorough inspection of the fire pump installation, including visual observation of the pump while running, to assure that the installation conforms to the contract requirements. Excessive vibration, leaks (oil or water), unusual noises, overheating, or other potential problems are not acceptable. Inspection includes piping and equipment clearance, access, supports, and guards. Bring any discrepancy to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered. The Fire Protection Specialist must witness the preliminary and final acceptance tests and, after completion of the inspections and a successful final acceptance test, sign test results and certify in writing that the installation the fire pump installation is in accordance with the contract requirements.

3.3 INSTALLATION

Provide equipment, materials, workmanship, fabrication, assembly, erection, installation, examination, inspection and testing in accordance NFPA 20, except as modified herein. In addition, install the fire pump and engine in accordance with the written instructions of the manufacturer.

3.3.1 Installation Drawings

Submit Fire Pump Installation Drawings consisting of a detailed plan view, detailed elevations and sections of the pump room, equipment and piping, drawn to a scale of not less than 1/2 inch = 1 foot. Indicate equipment, piping, and associated pump equipment to scale. Indicate all clearance, such as those between piping and equipment; between equipment and walls, ceiling and floors; and for electrical working distance clearance around all electrical equipment. Include a legend identifying all symbols, nomenclatures, and abbreviations. Indicate a complete piping and equipment layout including elevations and/or section views of the following:

a. Fire pumps, controllers, piping, valves, and associated equipment.

b. Sensing line for each pump including the pressure maintenance pump.

c. Engine fuel system for diesel driven pumps.

d. Engine cooling system for diesel driven pumps.

e. Pipe hangers and sway bracing including support for diesel muffler and exhaust piping.

f. Restraint of underground water main at entry-point to the building including details of pipe clamps, tie rods, mechanical retainer glands, and thrust blocks.

g. A one-line schematic diagram indicating layout and sizes of all piping, devices, valves and fittings.

h. A complete point-to-point connection drawing of the pump power, control and alarm systems, as well as interior wiring schematics of each controller.

3.3.2 Pump Room Configuration

Provide detail plan view of the pump room including elevations and sections showing the fire pumps, associated equipment, and piping. Submit working drawings on sheets not smaller than 24 by 36 inches; include data for the proper installation of each system. Show piping schematic of pumps, devices, valves, pipe, and fittings. Provide an isometric drawing of the fire pump and all associated piping. Show point to point electrical wiring diagrams. Show piping layout and sensing piping arrangement. Show engine fuel and cooling system. Include:

a. Pumps, drivers, and controllers

b. Hose valve manifold test header

c. Circuit diagrams for pumps

d. Wiring diagrams of each controller

3.3.3 Accessories

Furnish tank supports, piping offsets, fittings, and required accessories as specified to provide a complete installation and to eliminate interference with other construction.

3.4 PIPE AND FITTINGS

Piping must be inspected, tested and approved before burying, covering, or concealing. Provide fittings for changes in direction of piping and for all connections. Make changes in piping sizes using tapered reducing pipe fittings. Do not use bushings. Photograph all piping prior to burying, covering, or concealing.

3.4.1 Cleaning of Piping

Interior and ends of piping must be clean and free of any water or foreign material. Keep piping clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of the piping so that no water or foreign matter will enter the pipes or fittings. Inspect piping before placing in position.

3.4.2 Threaded Connections

Provide jointing compound for pipe threads consisting of polytetrafluoroethylene (PTFE) pipe thread tape conforming to ASTM D3308 and apply to male threads only. Provide exposed ferrous pipe threads with one coat of zinc molybdate primer applied to a minimum of dry film thickness of 1 mil.

3.4.3 Pipe Hangers and Supports

Provide additional hangers and supports for concentrated loads in aboveground piping, such as for valves and risers. All pipe shall be seismically restrained to Class "D". Refer to UFC 3-301-01.

3.4.3.1 Vertical Piping

Support piping at each floor, at no more than 10 foot intervals.

3.4.3.2 Horizontal Piping

Space horizontal piping supports as follows:

MAXIMUM SPACING (FEET)										
Nominal Pipe Size (inches)	1 and Under	1.25	1.5	2	2.5	3	3.5	4	5	6+
Copper Tube	6	7	8							
Steel Pipe	7	8	9	10	11	12	13	14	16	17

3.4.4 Underground Piping

Install underground piping and fittings in conformance to NFPA 24. Anchor joints in accordance with NFPA 24. Provide concrete thrust block at elbow where pipe turns up towards floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. After installation in accordance with NFPA 24, clean rods and nuts thoroughly and coat with asphalt or other corrosion-retard material approved by the Contracting Officer. Provide minimum cover depth of 6 feet.

3.4.5 Grooved Mechanical Joint

Prepare grooves according to the coupling manufacturer's instructions. Use grooved fittings, couplings, and grooving tools which are products of the same manufacturer. Ensure pipe and groove dimensions comply with the tolerances specified by the coupling manufacturer. Measure the diameter of grooves made in the field using a "go/no-go" gauge, vernier or dial caliper, narrow-land micrometer, or other method specifically approved by the coupling manufacturer for the intended application. Measure groove width and dimension of groove from end of pipe for each change in grooving tool setup to verify compliance with coupling manufacturer's tolerances. Do not use grooved joints in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

3.5 ELECTRICAL WORK

Provide electric motor and controls in accordance with NFPA 20, NFPA 72 and NFPA 70, unless more stringent requirements are specified herein or are indicated on the drawings. Provide electrical wiring and associated equipment in accordance with NFPA 20 and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide wiring in rigid metal conduit or intermediate metal conduit, except electrical metallic tubing conduit may be provided in dry locations not enclosed in concrete or where not subject to mechanical damage.

3.6 PIPE COLOR CODE MARKING

Color code marking of piping as specified in Section 09 90 00 PAINTS AND COATINGS. Fire sprinkler pipe shall be painted Red.

3.7 FLUSHING

Flush the fire pump suction and discharge piping at 120 percent of rated capacity of each pump. Where the pump installation consists of more than one pump, the flushing is the total quantity of water flowing when all pumps are discharging at 120 percent of their rated capacities. The new pumps may be used to attain the required flushing volume. Do not flush underground piping using the fire pumps. Continue flushing operations until water is clear, but no less than 10 minutes. Submit a signed and dated flushing certificate before requesting field testing.

3.8 FIELD TESTS

Submit system diagrams that show the layout of equipment, piping, and storage units, and typed condensed sequence of operation, wiring and control diagrams, and operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system must be framed under glass or laminated plastic. After approval, post these items where directed.

3.8.1 Hydrostatic Test

Hydrostatically test piping at 225 psig for a period of 2-hours, or at least 50 psiin excess of the maximum pressure, when the maximum pressure in the system is in excess of 175 psi in accordance with NFPA 20.

3.8.2 Preliminary Tests

Submit proposed procedures for Preliminary Tests prior to the proposed date and time to begin Preliminary Tests. The Fire Protection Specialist must take all readings and measurements. The Manufacturer's Representative, a representative of the fire pump controller manufacturer, and a representative of the diesel engine manufacturer (when supplied) must witness the complete operational testing of the fire pump and drivers. The fire pump controller manufacturer's representative and the diesel engine manufacturer's representative must each be an experienced technician employed by the respective manufacturers and capable of demonstrating operation of all features of respective components including trouble alarms and operating features. Thoroughly inspect and test fire pumps, drivers and equipment to insure that the system is correct, complete, and ready for operation. Ensure that pumps are operating at rated capacity, pressure and speed. Include manual starting and running to ensure proper operation and to detect leakage or other abnormal conditions, flow testing, automatic start testing, testing of automatic settings, sequence of operation check, test of required accessories; test of pump alarms devices and supervisory signals, test of pump cooling, operational test of relief valves, and test of automatic power transfer, if provided. Pumps must run without abnormal noise, vibration or heating. If any component or system was found to be defective, inoperative, or not in compliance with the contract requirements during the tests and inspection, make corrections and repeat the entire preliminary. Submit Preliminary Tests Reports, to include both the Contractor's Material and Test Certificate for Underground Piping and the

Contractor's Material and Test Certificate for Aboveground Piping. All items in the Report must be signed by the Fire Protection Specialist and the Manufacturer's Representative.

3.8.3 Test Equipment

Provide all equipment and instruments necessary to conduct a complete final test, including 2.5 inch diameter hoses, playpipe nozzles, pitot tube gauges, portable digital tachometer, voltage and ampere meters, and calibrated oil-filled water pressure gauges. Provide all necessary supports to safely secure hoses and nozzles during the test. The Government will furnish water for the tests.

3.9 DISINFECTION

After all system components are installed including pumps, piping, and other associated work, and all hydrostatic tests are successfully completed, thoroughly flush the pumps and all piping to be disinfected with potable water until there is no visible sign of dirt or other residue, and hydrostatic test are successfully completed, flush each portion of the piping specified in this Section system to be disinfected thoroughly with potable water until all entrained dirt and other foreign materials are removed before introducing chlorinating material.

3.9.1 Chlorination

Provide chlorinating material consisting of hypochlorites or liquid chlorine. Feed the chlorinating material into the sprinkler piping at a constant rate of 50 parts per million (ppm). Use a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or liquid chlorine injected into the system through a solution-fed chlorinator and booster pump. Continue chlorination application until the entire system is filled. Keep the water in the system for a minimum of 24 hours. Open and close each valve in the system several times to ensure its proper disinfection. Following the 24-hour period, allow no less than 25 ppm chlorine residual to remain in the system.

3.9.2 Flushing

Flush the system with clean water until the residual chlorine is reduced to less than one part per million. Samples of water in disinfected containers for bacterial examination will be taken from several system locations which are approved by the Contracting Officer.

3.9.3 Sample Testing

Test samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with AWWA 10084. Use either the multiple-tube fermentation technique or the membrane-filter technique testing method. Repeat disinfection until tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.10 SYSTEM STARTUP

Fully enclose or properly guard coupling, rotating parts, gears, projecting equipment, etc. so as to prevent possible injury to persons that come in close proximity of the equipment. Conduct testing of the

fire pumps in a safe manner and ensure that all equipment is safely secured. Use hoses and nozzles to conduct flow tests that are in excellent condition and safely anchor and secure to prevent any misdirection of the hose streams.

Post operating instructions for pumps, drivers, controllers, and flow meters.

3.11 CLOSEOUT ACTIVITIES

3.11.1 Field Training

Conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Submit the proposed schedule for field training at least 14 days prior to the start of related training. Provide training for a period of 8 hours of normal working time and start after the fire pump installation is functionally complete and after the Final Acceptance Test. Cover all of the items contained in the approved Operating and Maintenance Instructions. Submit manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance. Include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Submit Data Package 3 for fire pumps and drivers in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

3.11.2 As-Built Drawings

Submit As-Built Drawings, no later than 14 days after completion of the Final Tests. Update the Fire Pump Installation Drawings to reflect as-built conditions after all related work is completed and prepare drawings on reproducible full-size mylar film.

3.12 PROTECTION

Carefully remove materials so as not to damage material which is to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

-- End of Section --

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015; R 2020) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.1.2	(2012; R 2017; R 2022) Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors)
ASME A112.6.1M	(1997; R 2017) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.3	(2019) Standard for Floor and Trench Drains
ASME A112.19.2/CSA B45.1	(2018; ERTA 2018) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME A112.36.2M	(1991; R 2017) Cleanouts
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.15	(2018) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2021) Cast Copper Alloy Solder Joint Pressure Fittings

ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B16.50	(2021) Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
ASME B16.51	(2013) Copper and Copper Alloy Press-Connect Pressure Fittings
ASME B31.1	(2022) Power Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IV	(2017) BPVC Section IV-Rules for Construction of Heating Boilers
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME CSD-1	(2021) Control and Safety Devices for Automatically Fired Boilers

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1001	(2021) Performance Requirements for Atmospheric Type Vacuum Breakers
ASSE 1003	(2020) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1010	(2021) Performance Requirements for Water Hammer Arresters
ASSE 1011	(2017) Performance Requirements for Hose Connection Vacuum Breakers
ASSE 1012	(2023) Performance Requirements for Backflow Preventer with an Intermediate Atmospheric Vent
ASSE 1013	(2021) Performance Requirements for Reduced Pressure Principle Backflow

	Prevention Assemblies
ASSE 1018	(2001; R 2021) Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied (ANSI Approved 2002
ASSE 1019	(2011; R 2016) Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance
ASSE 1020	(2020) Performance Requirements for Pressure Vacuum Breaker Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater
AWWA B300	(2018) Hypochlorites
AWWA B301	(2018) Liquid Chlorine
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C606	(2022) Grooved and Shouldered Joints
AWWA C651	(2014) Standard for Disinfecting Water Mains
AWWA C652	(2019) Disinfection of Water-Storage Facilities
AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case
AWWA C701	(2019) Cold-Water Meters - Turbine Type for Customer Service
AWWA D100	(2021) Welded Steel Tanks for Water Storage

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS B2.2/B2.2M	(2016) Specification for Brazing Procedure and Performance Qualification

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A74	(2021) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A105/A105M	(2021) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A183	(2014; R 2020) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A515/A515M	(2017; R2022) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A516/A516M	(2017) Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM A888	(2021a) Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B42	(2020) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B43	(2020) Standard Specification for Seamless Red Brass Pipe, Standard Sizes
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B370	(2022) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper

	and Copper Alloy Tube
ASTM B828	(2016) Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings
ASTM C564	(2020a) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2235	(2004; R 2016) Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2822/D2822M	(2005; R 2011; E 2011) Standard Specification for Asphalt Roof Cement, Asbestos-Containing
ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3122	(1995; R 2009) Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings
ASTM D3138	(2004; R 2016) Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3311	(2017) Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM F409	(2022) Standard Specification for Thermoplastic Accessible and Replaceable

	Plastic Tube and Tubular Fittings
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	(2022) Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
ASTM F2389	(2023) Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(2018) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(2012) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015	(2016; 14/17) Copper Tube Handbook

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

IAPMO PS 117	(2005b) Press Type Or Plain End Rub Gasketed W/ Nail CU & CU Alloy Fittings 4 Install On CU Tubing

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2017) Standard And Commentary Accessible and Usable Buildings and Facilities
ICC IPC	(2021) International Plumbing Code

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z358.1	(2014; R 2020) American National Standard for Emergency Eyewash and Shower Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-25	(2018) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2022) Butterfly Valves

MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends

NACE INTERNATIONAL (NACE)

NACE SP0169	(2013) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

NSF INTERNATIONAL (NSF)

NSF 372	(2016) Drinking Water System Components - Lead Content
NSF/ANSI 14	(2023) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2022) Drinking Water System Components - Health Effects

PLASTIC PIPE AND FITTINGS ASSOCIATION (PPFA)

PPFA Fire Man	(2016) Firestopping: Plastic Pipe in Fire Resistive Construction

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(2010) Water Hammer Arresters Standard

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J1508	(2023) Hose Clamp Specifications

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SM 9223	(2004) Enzyme Substrate Coliform Test
PL 93-523	(1974; A 1999) Safe Drinking Water Act

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 141.80	National Primary Drinking Water Regulations; Control of Lead and Copper; General Requirements

UL SOLUTIONS (UL)

UL 174	(2004; Reprint Dec 2021) UL Standard for Safety Household Electric Storage Tank Water Heaters

1.2 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit all submittals
in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit all items designated with a "G, DO" concurrently in one complete system submittal to permit simultaneous review of items. Omission of a required item from the package may result in disapproval of the entire submittal. Unless otherwise indicated in the submittal review comments, disapproval of any item within the package will require a re-submittal of the entire system package, in which all deficiencies shall be corrected.Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Plumbing System; G, RO

Detail drawings consisting of schedules, performance charts, instructions, diagrams, and other information to illustrate the requirements and operations of systems that are not covered by the Plumbing Code. Detail drawings for the complete plumbing system including piping layouts and locations of connections; dimensions for roughing-in, foundation, and support points; schematic diagrams and wiring diagrams or connection and interconnection

diagrams. Detail drawings shall indicate clearances required for maintenance and operation. Where piping and equipment are to be supported other than as indicated, details shall include loadings and proposed support methods. Mechanical drawing plans, elevations, views, and details, shall be drawn to scale.

SD-03 Product Data

WATER HEATERS; G, DO

PUMPS; G, DO

Backflow Prevention Assemblies; G, RO

WaterSense Label for Lavatory Faucet

Fixtures

List of installed fixtures with manufacturer, model, and flow rate.

Flush Valve Water Closets

WaterSense Label for Flush Valve Water Closet

Wall Hung Lavatories

Service Sinks

Welding; G, RO

A copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators.

Plumbing System

Diagrams, instructions, and other sheets proposed for posting. Manufacturer's recommendations for the installation of bell and spigot and hubless joints for cast iron soil pipe.

SD-06 Test Reports

Tests, Flushing and Disinfection; G, RO

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

Test of Backflow Prevention Assemblies; G, RO.

Certification of proper operation shall be as accomplished in accordance with state regulations by an individual certified by the state to perform such tests. If no state requirement exists, the Contractor shall have the manufacturer's representative test the device, to ensure the unit is properly installed and performing as intended. The Contractor shall provide written documentation of the tests performed and signed by the individual

performing the tests.

SD-07 Certificates

Materials and Equipment

Where equipment is specified to conform to requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, and installation shall conform to the code.

Bolts

Written certification by the bolt manufacturer that the bolts furnished comply with the specified requirements.

SD-10 Operation and Maintenance Data

Plumbing System; G, RO

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.3 STANDARD PRODUCTS

Specified materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.3.1 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

1.3.2 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.3.3 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.3.4 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1.3.4.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.3.4.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.5 PERFORMANCE REQUIREMENTS

1.5.1 Welding

Piping shall be welded in accordance with qualified procedures using performance-qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer, may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests, and the tests shall be performed at the work site if practicable. Welders or welding operators shall apply their assigned symbols near each weld they make as a permanent record.

1.6 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC.

1.7 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.8 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work.

Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.9 ACCESSIBILITY OF EQUIPMENT

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.1 MATERIALS

Materials for various services shall be in accordance with TABLES I and II. Pipe schedules shall be selected based on service requirements. Pipe fittings shall be compatible with the applicable pipe materials. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for the service intended. Plastic pipe, fittings, and solvent cement used for potable hot and cold water service shall bear the NSF seal "NSF-PW." Polypropylene pipe and fittings shall conform to dimensional requirements of Schedule 40, Iron Pipe size and shall comply with NSF/ANSI 14, NSF/ANSI 61 and ASTM F2389. Polypropylene piping that will be exposed to UV light shall be provided with a Factory applied UV resistant coating. Pipe threads (except dry seal) shall conform to ASME B1.20.1. Grooved pipe couplings and fittings shall be from the same manufacturer. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61, Annex G or NSF 372. In line devices such as water meters, building valves, check valves, meter stops, valves, fittings and back flow preventers shall comply with PL 93-523 and NSF/ANSI 61, Section 8. End point devices such as drinking water fountains, lavatory faucets, kitchen and bar faucets, residential ice makers, supply stops and end point control valves used to dispense water for drinking must meet the requirements of NSF/ANSI 61, Section 9. Hubless cast-iron soil pipe shall not be installed underground, under concrete floor slabs, or in crawl spaces below kitchen floors. Plastic pipe shall not be installed in air plenums. Install backflow preventers for accessibility complying with

local code requirements, the International Building Code and the International Plumbing Code. State licensed plumbers shall install and/or test backflow preventers and cross connection devices. Perform initial testing and certification of new backflow devices and submit for approval prior to domestic water usage. Do not provide bypass piping around backflow preventers.

2.1.1 Pipe Joint Materials

Grooved pipe and hubless cast-iron soil pipe shall not be used underground. Solder containing lead shall not be used with copper pipe. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Institute. Joints and gasket materials shall conform to the following:

a. Coupling for Cast-Iron Pipe: for hub and spigot type ASTM A74, AWWA C606. For hubless type: CISPI 310

b. Coupling for Steel Pipe: AWWA C606.

c. Couplings for Grooved Pipe: Ductile Iron ASTM A536 (Grade 65-45-12) Malleable Iron ASTM A47/A47M, Grade 32510. Copper ASTM A536.

d. Flange Gaskets: Gaskets shall be made of non-asbestos material in accordance with ASME B16.21. Gaskets shall be flat, 1/16 inch thick, and contain Aramid fibers bonded with Styrene Butadiene Rubber (SBR) or Nitro Butadiene Rubber (NBR). Gaskets shall be the full face or self centering flat ring type. Gaskets used for hydrocarbon service shall be bonded with NBR.

e. Brazing Material: Brazing material shall conform to AWS A5.8/A5.8M, BCuP-5.

f. Brazing Flux: Flux shall be in paste or liquid form appropriate for use with brazing material. Flux shall be as follows: lead-free; have a 100 percent flushable residue; contain slightly acidic reagents; contain potassium borides; and contain fluorides.

g. Solder Material: Solder metal shall conform to ASTM B32.

h. Solder Flux: Flux shall be liquid form, non-corrosive, and conform to ASTM B813, Standard Test 1.

i. PTFE Tape: PTFE Tape, for use with Threaded Metal or Plastic Pipe.

j. Rubber Gaskets for Cast-Iron Soil-Pipe and Fittings (hub and spigot type and hubless type): ASTM C564.

k. Rubber Gaskets for Grooved Pipe: ASTM D2000, maximum temperature 230 degrees F.

l. Flexible Elastomeric Seals: ASTM D3139, ASTM D3212 or ASTM F477.

m. Bolts and Nuts for Grooved Pipe Couplings: Heat-treated carbon steel, ASTM A183.

n. Solvent Cement for Transition Joints between ABS and PVC Nonpressure Piping Components: ASTM D3138.

o. Plastic Solvent Cement for ABS Plastic Pipe: ASTM D2235.

p. Plastic Solvent Cement for PVC Plastic Pipe: ASTM D2564 and ASTM D2855.

q. Plastic Solvent Cement for CPVC Plastic Pipe: ASTM F493.

r. Flanged fittings including, but not limited to, flanges, bolts, nuts and bolt patterns shall be in accordance with ASME B16.5 class 150 and shall have the manufacturer's trademark affixed in accordance with MSS SP-25. Flange material shall conform to ASTM A105/A105M. Blind flange material shall conform to ASTM A516/A516M cold service and ASTM A515/A515M for hot service. Bolts shall be high strength or intermediate strength with material conforming to ASTM A193/A193M.

s. Plastic Solvent Cement for Styrene Rubber Plastic Pipe: ASTM D3122.

t. Press fittings for Copper Pipe and Tube: Copper press fittings shall conform to the material and sizing requirements of ASME B16.51 and performance criteria of IAPMO PS 117. Sealing elements for copper press fittings shall be EPDM, FKM or HNBR. Sealing elements shall be factory installed or an alternative supplied fitting manufacturer. Sealing element shall be selected based on manufacturer's approved application guidelines.

u. Copper tubing shall conform to ASTM B88, Type K, L or M.

v. Heat-fusion joints for polypropylene piping: ASTM F2389.

2.1.2 Miscellaneous Materials

Miscellaneous materials shall conform to the following:

a. Water Hammer Arrester: PDI WH 201. Water hammer arrester shall be diaphragm or piston type.

b. Copper, Sheet and Strip for Building Construction: ASTM B370.

c. Asphalt Roof Cement: ASTM D2822/D2822M.

d. Hose Clamps: SAE J1508.

e. Supports for Off-The-Floor Plumbing Fixtures: ASME A112.6.1M.

f. Metallic Cleanouts: ASME A112.36.2M.

g. Plumbing Fixture Setting Compound: A preformed flexible ring seal molded from hydrocarbon wax material. The seal material shall be nonvolatile nonasphaltic and contain germicide and provide watertight, gastight, odorproof and verminproof properties.

h. Coal-Tar Protective Coatings and Linings for Steel Water Pipelines: AWWA C203.

i. Hypochlorites: AWWA B300.

j. Liquid Chlorine: AWWA B301.

k. Gauges - Pressure and Vacuum Indicating Dial Type - Elastic Element: ASME B40.100.

l. Thermometers: ASTM E1. Mercury shall not be used in thermometers.

2.1.3 Pipe Insulation Material

Insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.2 PIPE HANGERS, INSERTS, AND SUPPORTS

Pipe hangers, inserts, and supports shall conform to MSS SP-58.

2.3 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

Description	Standard
Butterfly Valves	MSS SP-67
Cast-Iron Gate Valves, Flanged and Threaded Ends	MSS SP-70
Cast-Iron Swing Check Valves, Flanged and Threaded Ends	MSS SP-71
Ball Valves with Flanged Butt-Welding Ends for General Service	MSS SP-72
Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends	MSS SP-110
Cast-Iron Plug Valves, Flanged and Threaded Ends	MSS SP-78
Bronze Gate, Globe, Angle, and Check Valves	MSS SP-80
Steel Valves, Socket Welding and Threaded Ends	ASME B16.34
Cast-Iron Globe and Angle Valves, Flanged and Threaded Ends	MSS SP-85
Vacuum Relief Valves	ANSI Z21.22/CSA 4.4
Water Pressure Reducing Valves	ASSE 1003

Water Heater Drain Valves	ASME BPVC SEC IV, Part HLW-810: Requirements for Potable-Water Heaters Bottom Drain Valve
Trap Seal Primer Valves	ASSE 1018
Temperature and Pressure Relief Valves for Hot Water Supply Systems	ANSI Z21.22/CSA 4.4
Temperature and Pressure Relief Valves for Automatically Fired Hot Water Boilers	ASME CSD-1 Safety Code No., Part CW, Article 5

2.3.1 Hose Bibbs

Hose Bibbs with vacuum-breaker backflow preventer shall be brass with 3/4 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection. Faucet handle shall be securely attached to stem.

2.3.2 Freezeproof Wall Hydrants

ASSE 1019 with vacuum-breaker backflow preventer shall have a nickel-brass or nickel-bronze wall plate or flange with nozzle and detachable key handle. A brass or bronze operating rod shall be provided within a galvanized iron casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. The hydrant shall have 3/4 inch exposed hose thread on spout and 3/4 inch male pipe thread on inlet.

2.3.3 Relief Valves

Water heaters and hot water storage tanks shall have a combination pressure and temperature (P&T) relief valve. The pressure relief element of a P&T relief valve shall have adequate capacity to prevent excessive pressure buildup in the system when the system is operating at the maximum rate of heat input. The temperature element of a P&T relief valve shall have a relieving capacity which is at least equal to the total input of the heaters when operating at their maximum capacity. Relief valves shall be rated according to ANSI Z21.22/CSA 4.4. The discharge pipe from the relief valve shall be the size of the valve outlet.

2.3.4 Thermostatic Mixing Valves

Provide thermostatic mixing valve for lavatory faucets. Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature

changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 5 degrees F of any setting.

2.4 FIXTURES

Fixtures shall be water conservative type in accordance with ICC A117.1. Vitreous China, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, clear white, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers. Internal parts of flush valves and flushometer valves may contain acetal resin, fluorocarbon, nylon, acrylonitrile-butadiene-styrene (ABS) or other plastic material, if the material has provided satisfactory service under actual commercial or industrial operating conditions for not less than 2 years. Plastic in contact with hot water shall be suitable for 180 degrees F water temperature.

2.4.1 Flush Valve Water Closets

ASME A112.19.2/CSA B45.1, white vitreous china, siphon jet, elongated bowl, wall mounted, wall outlet. Top of toilet seat height above floor shall be 14 to 15 inches, except 17 to 19 inches for wheelchair water closets. Provide wax bowl ring including plastic sleeve. Provide white solid plastic elongated open-front seat .

Provide a dual-flush water closet and flush valve combination that will also provide a second flushing water volume not to exceed 1.28 gallons per flush. Water closets must meet the EPA WaterSense product definition specified in http://www.epa.gov/watersense/partners/product_program_specs.html and must be EPA WaterSense labeled products. Provide data identifying WaterSense label for flush valve water closet.

Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts, and wall plates; exposed to view components shall be chromium-plated or polished stainless steel. Flush valves shall be nonhold-open type. Mount flush valves not less than 11 inches above the fixture. Mounted height of flush valve shall not interfere with the hand rail in ADA stalls. Provide solenoid-activated flush valves including battery-operated light-beam-sensor to energize the solenoid.

2.4.2 Wall Hung Lavatories

ASME A112.19.2/CSA B45.1, white vitreous china, straight back type, minimum dimensions of 19 inches, wide by 17 inches front to rear, with supply openings for use with top mounted centerset faucets, and openings

for concealed arm carrier installation. Provide aerator with faucet. Lavatory Faucet shall have WaterSense Label for Lavatory Faucet. Water flow rate shall not exceed 0.5 gpm when measured at a flowing water pressure of 60 psi. Provide data identifying WaterSense label for the lavatory faucet. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports and concealed arms for the lavatory. Mount lavatory with the front rim 34 inches above floor and with 29 inches minimum clearance from bottom of the front rim to floor. Provide top-mounted solenoid-activated lavatory faucets including battery-operated light-beam-sensor to energize the solenoid.

2.4.3 Service Sinks

Composed of pearl gray marble chips and white portland cement ground smooth, grouted and sealed to resist stains, floor mounted. Stainless steel cap of one piece 20 ga 302 stainless steel caste integral on threshold. Dimensions shall be 32" x 32 x 12 inches deep.
Faucet and Spout - Cast or wrought copper alloy, with top or bottom brace, with backflow preventer. Faucets shall have replaceable seat and the washer shall rotate onto the seat. Handles shall be lever type. Strainers shall have internal threads. Provide at least one mop/broom rack hangar over sink.

Drain Assembly - Plug, cup strainer, crossbars, jam nuts, washers, couplings, stopper, etc., shall be copper alloy or stainless steel. Service sink shall be fitted with drains and traps not less than 3 inches in diameter.

2.4.4 Emergency Eyewash and Shower

ANSI/ISEA Z358.1, floor supported free standing unit. Provide deluge shower head, stay-open ball valve operated by pull rod and ring or triangular handle. Provide eyewash and stay-open ball valve operated by foot treadle or push handle. Provide with signage. Provide a pressure-compensated tempering valve, with leaving water temperature setpoint adjustable throughout at the range of 60 to 95 degrees F. Provide packaged, UL listed, alarm system; including an amber strobe lamp, horn with externally adjustable loudness and horn silencing switch, mounting hardware, and waterflow service.

2.5 BACKFLOW PREVENTERS

Backflow prevention devices must be approved by the State or local regulatory agencies. If there is no State or local regulatory agency requirements, the backflow prevention devices must be listed by the Foundation for Cross-Connection Control & Hydraulic Research, or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention devices and assemblies.

Reduced pressure principle assemblies, double check valve assemblies, atmospheric (nonpressure) type vacuum breakers, and pressure type vacuum breakers shall be meet the above requirements.

Backflow preventers with intermediate atmospheric vent shall conform to ASSE 1012. Reduced pressure principle backflow preventers shall conform to ASSE 1013. Hose connection vacuum breakers shall conform to ASSE 1011. Pipe applied atmospheric type vacuum breakers shall conform to ASSE 1001. Pressure vacuum breaker assembly shall conform to ASSE 1020. Air gaps in

plumbing systems shall conform to ASME A112.1.2.

2.6 DRAINS

2.6.1 Floor Drains

Floor drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor shall conform to ASME A112.6.3. Provide drain (FD-1) with trap primer connection, trap primer, and connection piping and provide floor drain (FD-2) with a deep seal trap and include a waterless trap seal.. Primer shall meet ASSE 1018.

2.6.2 Mechanical Room Drains

Mechancial Room drains shall have combined drain and deep-sealed trap, hinged grate, removable bucket, and threaded brass cleanout with brass backwater valve. The removable galvanized cast-iron sediment bucket shall have rounded corners to eliminate fouling and shall be equipped with hand grips. Drain shall have a minimum water seal of 4 inches. The grate area shall be not less than 100 square inches.

2.6.3 Floor Sinks

Floor sinks shall be square, with 12 inch nominal overall width or diameter and 10 inch nominal overall depth. Floor sink shall have an acid-resistant enamel interior finish with cast-iron body, ABS sediment bucket, and perforated grate of cast iron in industrial areas and stainless steel in finished areas. The outlet pipe size shall be as indicated or of the same size as the connecting pipe.

2.7 TRAPS

Unless otherwise specified, traps shall be plastic per ASTM F409 or copper-alloy adjustable tube type with slip joint inlet and swivel. Traps shall be without a cleanout. Provide traps with removable access panels for easy clean-out at sinks and lavatories. Tubes shall be copper alloy with walls not less than 0.032 inch thick within commercial tolerances, except on the outside of bends where the thickness may be reduced slightly in manufacture by usual commercial methods. Inlets shall have rubber washer and copper alloy nuts for slip joints above the discharge level. Swivel joints shall be below the discharge level and shall be of metal-to-metal or metal-to-plastic type as required for the application. Nuts shall have flats for wrench grip. Outlets shall have internal pipe thread, except that when required for the application, the outlets shall have sockets for solder-joint connections. The depth of the water seal shall be not less than 2 inches. The interior diameter shall be not more than 1/8 inch over or under the nominal size, and interior surfaces shall

be reasonably smooth throughout. A copper alloy "P" trap assembly consisting of an adjustable "P" trap and threaded trap wall nipple with cast brass wall flange shall be provided for lavatories. The assembly shall be a standard manufactured unit and may have a rubber-gasketed swivel joint.

2.8 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 90 to 160 degrees F. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III in PART 3 of this Section for each type of water heater specified. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 200 degrees F water temperature and 150 psi working pressure.

2.8.1 Automatic Storage Type

Heaters shall be complete with control system, and shall have ASME rated combination pressure and temperature relief valve.

2.8.1.1 Electric Type

Electric type water heaters shall conform to UL 174 with dual heating elements. Each element shall be 4.5 KW. The elements shall be wired so that only one element can operate at a time.

2.9 HOT-WATER STORAGE TANKS

Hot-water storage tanks shall be constructed by one manufacturer, ASME stamped for the working pressure, and shall have the National Board (ASME) registration. The tank shall be cement-lined or glass-lined steel type in accordance with AWWA D100. The heat loss shall conform to TABLE III in PART 3 of this Section as determined by the requirements of ASHRAE 90.1 - IP. Each tank shall be equipped with a thermometer, conforming to ASTM E1, Type I, Class 3, Range C, style and form as required for the installation, and with 7 inch scale. Thermometer shall have a separable socket suitable for a 3/4 inch tapped opening. Tanks shall be equipped with a pressure gauge 6 inch minimum diameter face. Insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Storage tank capacity shall be as shown.

2.10 PUMPS

2.10.1 Circulating Pumps

Domestic hot water circulating pumps shall be electrically driven, single-stage, centrifugal, with mechanical seals, suitable for the intended service. Pump and motor shall be supported by the piping on which it is installed. The shaft shall be one-piece, heat-treated, corrosion-resisting steel with impeller and smooth-surfaced housing of bronze.

Motor shall be totally enclosed, fan-cooled and shall have sufficient horsepower for the service required. Each pump motor shall be equipped

with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in cover.

Integral size motors shall be premium efficiency type in accordance with NEMA MG 1. Pump motors smaller than 1 hp Fractional horsepower pump motors shall have integral thermal overload protection in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Guards shall shield exposed moving parts.

2.10.2 Flexible Connectors

Flexible connectors shall be provided at the suction and discharge of each pump that is 1 hp or larger. Connectors shall be constructed of neoprene, rubber, or braided bronze, with Class 150 standard flanges. Flexible connectors shall be line size and suitable for the pressure and temperature of the intended service.

2.11 DOMESTIC WATER SERVICE METER

Cold water meters 2 inches and smaller shall be positive displacement type conforming to AWWA C700. Cold water meters 2-1/2 inches and larger shall be turbine type conforming to AWWA C701. Meter register may be round or straight reading type, indicating gallons or as provided by the local utility. Meter shall be provided with a pulse generator, remote readout register and all necessary wiring and accessories.

Meters must be connected to the base wide energy and utility monitoring and control system using the installation's advanced metering protocols.

2.12 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, corresponding to the applications in accordance with NEMA MG 11. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Controllers and contactors shall have auxiliary contacts for use with the controls provided. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers, including the required monitors and timed restart.

Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.13 MISCELLANEOUS PIPING ITEMS

2.13.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

2.13.2 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade, except where penetrating a membrane waterproof floor.

2.13.2.1 Sleeves in Masonry and Concrete

Provide steel pipe sleeves or schedule 40 PVC plastic pipe sleeves. Sleeves are not required where drain, waste, and vent (DWV) piping passes through concrete floor slabs located on grade. Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in the core-drilled hole are completely grouted smooth.

2.13.2.2 Sleeves Not in Masonry and Concrete

Provide 26 gage galvanized steel sheet or PVC plastic pipe sleeves.

2.13.3 Pipe Hangers (Supports)

Provide MSS SP-58 Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shield for insulated piping.

2.13.4 Nameplates

Provide 0.125 inch thick melamine laminated plastic nameplates, black matte finish with white center core, for equipment, gages, thermometers, and valves; valves in supplies to faucets will not require nameplates. Accurately align lettering and engrave minimum of 0.25 inch high normal block lettering into the white core. Minimum size of nameplates shall be 1.0 by 2.5 inches. Key nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Piping located in air plenums shall conform to NFPA 90A requirements. Piping located in shafts that constitute air ducts or that enclose air ducts shall be noncombustible in accordance with NFPA 90A. Installation

of plastic pipe where in compliance with NFPA may be installed in accordance with PPFA Fire Man. The plumbing system shall be installed complete with necessary fixtures, fittings, traps, valves, and accessories. Water and drainage piping shall be extended 5 feet outside the building, unless otherwise indicated. A full port ball valve and drain shall be installed on the water service line inside the building approximately 6 inches above the floor from point of entry. Piping shall be connected to the exterior service lines or capped or plugged if the exterior service is not in place. Sewer and water pipes shall be laid in separate trenches, except when otherwise shown. Exterior underground utilities shall be at least 12 inches below the average local frost depth or as indicated on the drawings. If trenches are closed or the pipes are otherwise covered before being connected to the service lines, the location of the end of each plumbing utility shall be marked with a stake or other acceptable means. Valves shall be installed with control no lower than the valve body.

3.1.1 Water Pipe, Fittings, and Connections

3.1.1.1 Utilities

The piping shall be extended to fixtures, outlets, and equipment. The hot-water and cold-water piping system shall be arranged and installed to permit draining. The supply line to each item of equipment or fixture, except faucets, flush valves, or other control valves which are supplied with integral stops, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to fixtures, faucets, hydrants, shower heads, and flushing devices shall be anchored to prevent movement.

3.1.1.2 Cutting and Repairing

The work shall be carefully laid out in advance, and unnecessary cutting of construction shall be avoided. Damage to building, piping, wiring, or equipment as a result of cutting shall be repaired by mechanics skilled in the trade involved.

3.1.1.3 Protection of Fixtures, Materials, and Equipment

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, chemicals, and mechanical injury. Upon completion of the work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Safety guards shall be provided for exposed rotating equipment.

3.1.1.4 Mains, Branches, and Runouts

Piping shall be installed as indicated. Pipe shall be accurately cut and worked into place without springing or forcing. Structural portions of the building shall not be weakened. Aboveground piping shall run parallel with the lines of the building, unless otherwise indicated. Branch pipes from service lines may be taken from top, bottom, or side of main, using crossover fittings required by structural or installation conditions. Supply pipes, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. Bare and insulated water lines shall not bear directly against building structural elements

so as to transmit sound to the structure or to prevent flexible movement of the lines. Water pipe shall not be buried in or under floors unless specifically indicated or approved. Changes in pipe sizes shall be made with reducing fittings. Use of bushings will not be permitted except for use in situations in which standard factory fabricated components are furnished to accommodate specific accepted installation practice. Change in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. The center-line radius of bends shall be not less than six diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be acceptable.

3.1.1.5 Pipe Drains

Pipe drains indicated shall consist of 3/4 inch hose bibb with renewable seat and full port ballvalve ahead of hose bibb. At other low points, 3/4 inch brass plugs or caps shall be provided. Disconnection of the supply piping at the fixture is an acceptable drain.

3.1.1.6 Expansion and Contraction of Piping

Allowance shall be made throughout for expansion and contraction of water pipe. Each hot-water and hot-water circulation riser shall have expansion loops or other provisions such as offsets and changes in direction where indicated and required. Risers shall be securely anchored as required or where indicated to force expansion to loops. Branch connections from risers shall be made with ample swing or offset to avoid undue strain on fittings or short pipe lengths. Horizontal runs of pipe over 50 feet in length shall be anchored to the wall or the supporting construction about midway on the run to force expansion, evenly divided, toward the ends. Sufficient flexibility shall be provided on branch runouts from mains and risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that piping will spring enough to allow for expansion without straining. If mechanical grooved pipe coupling systems are provided, the deviation from design requirements for expansion and contraction may be allowed pending approval of Contracting Officer.

3.1.1.7 Thrust Restraint

Plugs, caps, tees, valves and bends deflecting 11.25 degrees or more, either vertically or horizontally, in waterlines 4 inches in diameter or larger shall be provided with thrust blocks, where indicated, to prevent movement. Thrust blocking shall be concrete of a mix not leaner than: 1 cement, 2-1/2 sand, 5 gravel; and having a compressive strength of not less than 2000 psi after 28 days. Blocking shall be placed between solid ground and the fitting to be anchored. Unless otherwise indicated or directed, the base and thrust bearing sides of the thrust block shall be poured against undisturbed earth. The side of the thrust block not subject to thrust shall be poured against forms. The area of bearing will be as shown. Blocking shall be placed so that the joints of the fitting are accessible for repair. Steel rods and clamps, protected by galvanizing or by coating with bituminous paint, shall be used to anchor vertical down bends into gravity thrust blocks.

3.1.1.8 Commercial-Type Water Hammer Arresters

Commercial-type water hammer arresters shall be provided on hot- and cold-water supplies and shall be located as generally indicated, with

precise location and sizing to be in accordance with PDI WH 201. Water hammer arresters, where concealed, shall be accessible by means of access doors or removable panels. Commercial-type water hammer arresters shall conform to ASSE 1010. Vertical capped pipe columns will not be permitted.

3.1.2 Joints

Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints shall be made up with fittings of compatible material and made for the specific purpose intended.

3.1.2.1 Threaded

Threaded joints shall have American Standard taper pipe threads conforming to ASME B1.20.1. Only male pipe threads shall be coated with graphite or with an approved graphite compound, or with an inert filler and oil, or shall have a polytetrafluoroethylene tape applied.

3.1.2.2 Mechanical Couplings

Mechanical couplings may be used in conjunction with grooved pipe for aboveground, ferrous or non-ferrous, domestic hot and cold water systems, in lieu of unions, brazed, soldered, welded, flanged, or threaded joints.

Mechanical couplings are permitted in accessible locations including behind access plates. Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment. Rigid grooved joints shall incorporate an angle bolt pad design which maintains metal-to-metal contact with equal amount of pad offset of housings upon installation to ensure positive rigid clamping of the pipe.

Designs which can only clamp on the bottom of the groove or which utilize gripping teeth or jaws, or which use misaligned housing bolt holes, or which require a torque wrench or torque specifications will not be permitted.

Rigid grooved pipe couplings shall be for use with grooved end pipes, fittings, valves and strainers. Rigid couplings shall be designed for not less than 125 psi service and appropriate for static head plus the pumping head, and shall provide a watertight joint.

Grooved fittings and couplings, and grooving tools shall be provided from the same manufacturer. Segmentally welded elbows shall not be used. Grooves shall be prepared in accordance with the coupling manufacturer's latest published standards. Grooving shall be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations.

The Contracting Officer shall be notified 24 hours in advance of test to demonstrate operator's capability, and the test shall be performed at the work site, if practical, or at a site agreed upon. The operator shall demonstrate the ability to properly adjust the grooving tool, groove the pipe, and to verify the groove dimensions in accordance with the coupling manufacturer's specifications.

3.1.2.3 Unions and Flanges

Unions, flanges and mechanical couplings shall not be concealed in walls, ceilings, or partitions. Unions shall be used on pipe sizes 2-1/2 inches and smaller; flanges shall be used on pipe sizes 3 inches and larger.

3.1.2.4 Cast Iron Soil, Waste and Vent Pipe

Bell and spigot compression and hubless gasketed clamp joints for soil, waste and vent piping shall be installed per the manufacturer's recommendations.

3.1.2.5 Copper Tube and Pipe

a. Brazed. Brazed joints shall be made in conformance with AWS B2.2/B2.2M, ASME B16.50, and CDA A4015 with flux and are acceptable for all pipe sizes. Copper to copper joints shall include the use of copper-phosphorus or copper-phosphorus-silver brazing metal without flux. Brazing of dissimilar metals (copper to bronze or brass) shall include the use of flux with either a copper-phosphorus, copper-phosphorus-silver or a silver brazing filler metal.

b. Soldered. Soldered joints shall be made with flux and are only acceptable for piping 2 inches and smaller. Soldered joints shall conform to ASME B31.5 and CDA A4015.

c. Copper Tube Extracted Joint. Mechanically extracted joints shall be made in accordance with ICC IPC.

d. Press connection. Copper press connections shall be made in **strict** accordance with the manufacturer's installation instructions for manufactured rated size. The joints shall be pressed using the tool(s) approved by the manufacturer **of that joint**. Minimum distance between fittings shall be in accordance with the manufacturer's requirements.

3.1.2.6 Plastic Pipe

Acrylonitrile-Butadiene-Styrene (ABS) pipe shall have joints made with solvent cement. PVC and CPVC pipe shall have joints made with solvent cement elastomeric, threading, (threading of Schedule 80 Pipe is allowed only where required for disconnection and inspection; threading of Schedule 40 Pipe is not allowed), or mated flanged.

3.1.2.7 Polypropylene Pipe

Joints for polypropylene pipe and fittings shall be made by heat fusion welding socket-type or butt-fusion type fittings and shall comply with ASTM F2389.

3.1.3 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric

flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.1.4 Corrosion Protection for Buried Pipe and Fittings

Ductile iron, cast iron, and steel pipe, fittings, and joints shall have a protective coating. Additionally, ductile iron, cast iron, and steel pressure pipe shall have a cathodic protection system and joint bonding. The cathodic protection system, protective coating system, and joint bonding for cathodically protected pipe shall be in accordance with Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM. Coatings shall be selected, applied, and inspected in accordance with NACE SP0169 and as otherwise specified. The pipe shall be cleaned and the coating system applied prior to pipe tightness testing. Joints and fittings shall be cleaned and the coating system applied after pipe tightness testing. For tape coating systems, the tape shall conform to AWWA C203 and shall be applied with a 50 percent overlap. Primer utilized with tape type coating systems shall be as recommended by the tape manufacturer.

3.1.5 Pipe Sleeves and Flashing

Pipe sleeves shall be furnished and set in their proper and permanent location.

3.1.5.1 Sleeve Requirements

Unless indicated otherwise, provide pipe sleeves meeting the following requirements:

a. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors.

b. A modular mechanical type sealing assembly may be installed in lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve. The seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve using galvanized steel bolts, nuts, and pressure plates. The links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal between the pipe and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe and sleeve involved.

c. Sleeves shall not be installed in structural members, except where indicated or approved. Rectangular and square openings shall be as detailed. Each sleeve shall extend through its respective floor, or roof, and shall be cut flush with each surface, except for special circumstances. Pipe sleeves passing through floors in wet areas such as mechanical equipment rooms, lavatories, kitchens, and other plumbing fixture areas shall extend a minimum of 4 inches above the finished floor.

d. Unless otherwise indicated, sleeves shall be of a size to provide a

minimum of 1/4 inch clearance between bare pipe or insulation and inside of sleeve or between insulation and inside of sleeve. Sleeves in bearing walls and concrete slab on grade floors shall be steel pipe or cast-iron pipe. Sleeves in nonbearing walls or ceilings may be steel pipe, cast-iron pipe, galvanized sheet metal with lock-type longitudinal seam, or plastic.

e. Except as otherwise specified, the annular space between pipe and sleeve, or between jacket over insulation and sleeve, shall be sealed as indicated with sealants conforming to ASTM C920 and with a primer, backstop material and surface preparation as specified in Section 07 92 00 JOINT SEALANTS. The annular space between pipe and sleeve, between bare insulation and sleeve or between jacket over insulation and sleeve shall not be sealed for interior walls which are not designated as fire rated.

f. Sleeves through below-grade walls in contact with earth shall be recessed 1/2 inch from wall surfaces on both sides. Annular space between pipe and sleeve shall be filled with backing material and sealants in the joint between the pipe and concrete or masonry wall as specified above. Sealant selected for the earth side of the wall shall be compatible with dampproofing/waterproofing materials that are to be applied over the joint sealant. Pipe sleeves in fire-rated walls shall conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.1.5.2 Flashing Requirements

Pipes passing through roof shall be installed through a 16 ounce copper flashing boot provided by the roof manufacturer. Flashing shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall be set over the roof in accordance with the roof manufactuer's requirements. The flashing shall extend up the pipe a minimum of 10 inches.

3.1.5.3 Waterproofing

Waterproofing at floor-mounted water closets shall be accomplished by sealing the annular space between the pipe sleve and drain pipe.

3.1.5.4 Pipe Penetrations of Slab on Grade Floors

Waterproofing at floor-mounted water closets shall be accomplished by sealing the annular space between the pipe sleeve and the drain pipe..

3.1.5.5 Pipe Penetrations

Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed to prevent infiltration of air, insects, and vermin.

3.1.6 Fire Seal

Where pipes pass through fire walls, fire-partitions, fire-rated pipe chase walls or floors above grade, a fire seal shall be provided as specified in Section 07 84 00 FIRESTOPPING.

3.1.7 Supports

3.1.7.1 General

Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement when operating temperatures exceed ambient temperatures shall be supported by variable spring hangers and supports or by constant support hangers. In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run. Threaded sections of rods shall not be formed or bent.

3.1.7.2 Pipe Supports and Structural Bracing, Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided. Material used for supports shall be as specified in Section 05 12 00 STRUCTURAL STEEL Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS Section 05 52 00 METAL RAILINGS, Section 05 51 00 METAL STAIRS.

3.1.7.3 Pipe Hangers, Inserts, and Supports

Installation of pipe hangers, inserts and supports shall conform to MSS SP-58 except as modified herein.

a. Types 5, 12, and 26 shall not be used.

b. Type 3 shall not be used on insulated pipe.

c. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for type 18 inserts.

d. Type 19 and 23 C-clamps shall be torqued per MSS SP-58 and shall have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

e. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

f. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

g. Type 39 saddles shall be used on insulated pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 39 saddles shall be welded to the pipe.

h. Type 40 shields shall:

(1) Be used on insulated pipe less than 4 inches.

(2) Be used on insulated pipe 4 inches and larger when the temperature

of the medium is 60 degrees F or less.

(3) Have a high density insert for all pipe sizes. High density inserts shall have a density of 8 pcf or greater.

i. Horizontal pipe supports shall be spaced as specified in MSS SP-58 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Operating temperatures in determining hanger spacing for PVC or CPVC pipe shall be 120 degrees F for PVC and 180 degrees F for CPVC. Horizontal pipe runs shall include allowances for expansion and contraction.

j. Vertical pipe shall be supported at each floor, except at slab-on-grade, at intervals of not more than 15 feet nor more than 8 feet from end of risers, and at vent terminations. Vertical pipe risers shall include allowances for expansion and contraction.

k. Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided to allow longitudinal pipe movement. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered. Lateral restraints shall be provided as needed. Where steel slides do not require provisions for lateral restraint the following may be used:

(1) On pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher, a Type 39 saddle, welded to the pipe, may freely rest on a steel plate.

(2) On pipe less than 4 inches a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

(3) On pipe 4 inches and larger carrying medium less that 60 degrees F a Type 40 shield, attached to the pipe or insulation, may freely rest on a steel plate.

l. Pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation. The insulation shall be continuous through the hanger on all pipe sizes and applications.

m. Where there are high system temperatures and welding to piping is not desirable, the type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches or by an amount adequate for the insulation, whichever is greater.

n. Hangers and supports for plastic pipe shall not compress, distort, cut or abrade the piping, and shall allow free movement of pipe except where otherwise required in the control of expansion/contraction.

3.1.7.4 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floor or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

3.1.8 Welded Installation

Plumbing pipe weldments shall be as indicated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. Branch connection may be made with either welding tees or forged branch outlet fittings. Branch outlet fittings shall be forged, flared for improvement of flow where attached to the run, and reinforced against external strains. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and repairs made to the weld, or the weld joints shall be entirely removed and rewelded. After filler metal has been removed from its original package, it shall be protected or stored so that its characteristics or welding properties are not affected. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.9 Pipe Cleanouts

Pipe cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown. An extra-heavy cast-brass or cast-iron ferrule with countersunk cast-brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe, where indicated, shall be T-pattern, 90-degree branch drainage fittings with cast-brass screw plugs, except plastic plugs shall be installed in plastic pipe. Plugs shall be the same size as the pipe up to and including 4 inches. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, at the foot of interior downspouts, on each connection to building storm drain where interior downspouts are indicated, and on each building drain outside the building. Cleanout tee branches may be omitted on stacks in single story buildings with slab-on-grade construction or where less than 18 inches of crawl space is provided under the floor. Cleanouts on pipe concealed in partitions shall be provided with chromium plated bronze, nickel bronze, nickel brass or stainless steel flush type access cover plates. Round access covers shall be provided and secured to plugs with securing screw. Square access covers may be provided with matching frames, anchoring lugs and cover screws. Cleanouts in finished walls shall have access covers and frames installed flush with the finished wall. Cleanouts installed in finished floors subject to foot traffic shall be provided with a chrome-plated cast brass, nickel brass, or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface. Where cleanouts are provided with adjustable heads, the heads shall be cast iron or plastic.

3.2 WATER HEATERS

3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and

mounted above and within 6 inches above the top of the tank or water heater.

3.2.2 Heat Traps

Piping to and from each water heater and hot water storage tank shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

3.2.3 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges. Use of dielectric nipples is prohibited unless
internally lined and specifically designed to limit current flow between dissimilar metals.

3.2.4 Expansion Tank

A pre-charged expansion tank shall be installed on the cold water supply between the water heater inlet and the cold water supply shut-off valve. The Contractor shall adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

3.3 FIXTURES AND FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

3.3.1 Fixture Connections

Where space limitations prohibit standard fittings in conjunction with the cast-iron floor flange, special short-radius fittings shall be provided. Connections between earthenware fixtures and flanges on soil pipe shall be made gastight and watertight with a closet-setting compound or neoprene gasket and seal. Use of natural rubber gaskets or putty will not be permitted. Fixtures with outlet flanges shall be set the proper distance from floor or wall to make a first-class joint with the closet-setting compound or gasket and fixture used.

3.3.2 Flushometer Valves

Flushometer valves shall be secured to prevent movement by anchoring the long finished top spud connecting tube to wall adjacent to valve with approved metal bracket. Flushometer valves for water closets shall be installed 39 inches above the floor, except at water closets intended for use by the physically handicapped where flushometer valves must be mounted

at approximately 30 inches above the floor and arranged to avoid interference with grab bars. In addition, for water closets intended for handicap use, the flush valve handle must be installed on the wide side of the enclosure.

3.3.3 Height of Fixture Rims Above Floor

Lavatories shall be mounted with rim 31 inches above finished floor.

3.3.4 Fixture Supports

Fixture supports for off-the-floor lavatories, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

3.3.4.1 Support for Solid Masonry Construction

Chair carrier shall be anchored to the floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be imbedded in the masonry wall.

3.3.4.2 Support for Concrete-Masonry Wall Construction

Chair carrier shall be anchored to floor slab. Where a floor-anchored chair carrier cannot be used, a suitable wall plate shall be fastened to the concrete wall using through bolts and a back-up plate.

3.3.4.3 Support for Steel Stud Frame Partitions

Chair carrier shall be used. The anchor feet and tubular uprights shall be of the heavy duty design; and feet (bases) shall be steel and welded to a square or rectangular steel tube upright. Wall plates, in lieu of floor-anchored chair carriers, shall be used only if adjoining steel partition studs are suitably reinforced to support a wall plate bolted to these studs.

3.3.4.4 Support for Wood Stud Construction

Where floor is a concrete slab, a floor-anchored chair carrier shall be used. Where entire construction is wood, wood crosspieces shall be installed. Fixture hanger plates, supports, brackets, or mounting lugs shall be fastened with not less than No. 10 wood screws, 1/4 inch thick minimum steel hanger, or toggle bolts with nut. The wood crosspieces shall extend the full width of the fixture and shall be securely supported.

3.3.4.5 Wall-Mounted Water Closet Gaskets

Where wall-mounted water closets are provided, reinforced wax, treated felt, or neoprene gaskets shall be provided. The type of gasket furnished shall be as recommended by the chair-carrier manufacturer.

3.3.5 Backflow Prevention Devices

Plumbing fixtures, equipment, and pipe connections shall not cross connect

or interconnect between a potable water supply and any source of nonpotable water. Backflow preventers shall be installed where indicated and in accordance with ICC IPC at all other locations necessary to preclude a cross-connect or interconnect between a potable water supply and any nonpotable substance. In addition backflow preventers shall be installed at all locations where the potable water outlet is below the flood level of the equipment, or where the potable water outlet will be located below the level of the nonpotable substance. Backflow preventers shall be located so that no part of the device will be submerged. Backflow preventers shall be of sufficient size to allow unrestricted flow of water to the equipment, and preclude the backflow of any nonpotable substance into the potable water system. Bypass piping shall not be provided around backflow preventers. Access shall be provided for maintenance and testing. Each device shall be a standard commercial unit.

3.3.6 Access Panels

Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced.

3.3.7 Traps

Each trap shall be placed as near the fixture as possible, and no fixture shall be double-trapped. Traps installed on cast-iron soil pipe shall be cast iron. Traps installed on steel pipe or copper tubing shall be recess-drainage pattern, or brass-tube type. Traps installed on plastic pipe may be plastic conforming to ASTM D3311. Traps for acid-resisting waste shall be of the same material as the pipe.

3.4 WATER METER REMOTE READOUT REGISTER

The remote readout register shall be mounted at the location indicated or as directed by the Contracting Officer. Provide isolation valves on each side of the meter to allow for removal. Provide a building piping drain valve downstream of the meter. Provide input from the meter to the building direct digital control system to transmit water usage data.

3.5 IDENTIFICATION SYSTEMS

3.5.1 Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

3.5.2 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.6 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated

piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

3.7 PAINTING

Painting of pipes, hangers, supports, and other iron work, either in concealed spaces or exposed spaces, is specified in Section 09 90 00 PAINTS AND COATINGS.

3.7.1 Painting of New Equipment

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

3.7.1.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

3.7.1.2 Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

b. Temperatures Between 120 and 400 Degrees F: Metal surfaces subject to

temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 Degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

3.8 TESTS, FLUSHING AND DISINFECTION

3.8.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC IPC, , except that the drainage and vent system final test shall include the smoke test. The Contractor has the option to perform a peppermint test in lieu of the smoke test. If a peppermint test is chosen, the Contractor must submit a testing procedure and reasons for choosing this option in lieu of the smoke test to the Contracting Officer for approval.

a. Drainage and Vent Systems Test. The final test shall include a smoke test.

b. Building Sewers Tests.

c. Water Supply Systems Tests.

3.8.1.1 Test of Backflow Prevention Assemblies

Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies.

Backflow prevention assembly test gauges shall be tested annually for accuracy in accordance with the requirements of State or local regulatory agencies. If there is no State or local regulatory agency requirements, gauges shall be tested annually for accuracy in accordance with the requirements of University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14), or any other approved testing laboratory having equivalent capabilities for both laboratory and field evaluation of backflow prevention assembly test gauges. Report form for each assembly shall include, as a minimum, the following:

Data on Device	Data on Testing Firm
Type of Assembly	Name
Manufacturer	Address
Model Number	Certified Tester
Serial Number	Certified Tester No.
Size	Date of Test

Location	
Test Pressure Readings	Serial Number and Test Data of Gauges

If the unit fails to meet specified requirements, the unit shall be repaired and retested.

3.8.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

3.8.3 System Flushing

3.8.3.1 During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF/ANSI 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

3.8.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Flow rates on fixtures must not exceed those stated in PART 2 of this Section. Unless more stringent local requirements exist, lead levels shall not exceed limits established by 40 CFR 141.80 (c)(1). The water supply to the building shall be tested separately to ensure that any lead contamination found during potable water system testing is due to work being performed inside the building.

3.8.4 Operational Test

Upon completion of flushing and prior to disinfection procedures, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory installation, connections, adjustments, and functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system and shall include the following information in a report with conclusion as to the adequacy of the system:

a. Time, date, and duration of test.

b. Water pressures at the most remote and the highest fixtures.

c. Operation of each fixture and fixture trim.

d. Operation of each valve, hydrant, and faucet.

e. Temperature of each domestic hot-water supply.

f. Operation of each floor drain by flooding with water.

g. Operation of each vacuum breaker and backflow preventer.

3.8.5 Disinfection

After all system components are provided and operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

Test the chlorine residual level in the water at 6 hour intervals for a continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each valve and faucet shall be opened and closed several times.

After the second 24 hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than one part per million. During the flushing period, each valve and faucet shall be opened and closed several times.

Take additional samples of water in disinfected containers, for bacterial examination, at locations specified by the Contracting Officer. Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with EPA SM 9223 or AWWA 10084. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

Disinfection shall be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

3.9 POSTED INSTRUCTIONS

Framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, shall be posted where directed. Condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system shall be prepared in typed form, framed as specified above for the wiring and control diagrams and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the systems.

3.10 PERFORMANCE OF WATER HEATING EQUIPMENT

Standard rating condition terms are as follows:

EF = Energy factor, minimum overall efficiency.

ET = Minimum thermal efficiency with 70 degrees F delta T.

SL = Standby loss is maximum (Btu/h) based on a 70 degrees F temperature difference between stored water and ambient requirements.

V = Rated volume in gallons

Q = Nameplate input rate in kW (Btu/h)

3.10.1 Electric

a. Storage capacity of 60 gallons shall have a minimum energy factor (EF) of 0.93 or higher per FEMP requirements.

b. Storage capacity of 60 gallons or more shall have a minimum energy factor (EF) of 0.91 or higher per FEMP requirements.

3.11 TABLES

TABLE I

PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E
1	Cast iron soil pipe and fittings, hub and spigot, ASTM A74 with compression gaskets. Pipe and fittings shall be marked with the CISPI trademark.	X	X	X	X	
2	Cast iron soil pipe and fittings hubless, CISPI 301 and ASTM A888. Pipe and fittings shall be marked with the CISPI trademark.		X	X	X	
3	Cast iron drainage fittings, threaded, ASME B16.12 for use with Item 10	X		X	X	
4	Cast iron screwed fittings (threaded) ASME B16.4 for use with Item 10				X	

TABLE I						
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS						
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E
9	Malleable-iron threaded fittings, galvanized ASME B16.3 for use with Item 10				X	
10	Steel pipe, seamless galvanized, ASTM A53/A53M, Type S, Grade B	X			X	
11	Seamless red brass pipe, ASTM B43				X	X
12	Bronzed flanged fittings, ASME B16.24 for use with Items 11				X	X
15	Cast bronze threaded fittings, ASME B16.15				X	
16	Copper drainage tube, (DWV), ASTM B306	X*	X	X*	X	X

TABLE I						
PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS						
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E
17	Wrought copper and wrought alloy solder-joint drainage fittings. ASME B16.29	X	X	X	X	X
18	Cast copper alloy solder joint drainage fittings, DWV, ASME B16.23	X	X	X	X	X
19	Acrylonitrile-Butad -Styrene (ABS) plastic drain, waste, and vent pipe and fittings ASTM D2661, ASTM F628	X	X	X	X	
20	Polyvinyl Chloride plastic drain, waste and vent pipe and fittings, ASTM D2665, ASTM F891, (Sch 40) ASTM F1760	X	X	X	X	X
22	High-silicon content cast iron pipe and fittings (hub and spigot, and mechanical joint), ASTM A518/A518M		X			

TABLE I

PIPE AND FITTING MATERIALS FOR DRAINAGE, WASTE, VENT AND CONDENSATE DRAIN PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D	SERVICE E

SERVICE:

A - Underground Building Soil, Waste and Storm Drain
B - Aboveground Soil, Waste, Drain In Buildings
C - Underground Vent
D - Aboveground Vent
E - Condensate Drain Aboveground

* - Hard Temper

TABLE II

PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS

Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D
1	Malleable-iron threaded fittings:				
	a. Galvanized, ASME B16.3 for use with Item 4a			X	
	b. Same as "a" but not galvanized for use with Item 4b			X	
4	Steel pipe:				
	a. Seamless, galvanized, ASTM A53/A53M, Type S, Grade B			X	
	b. Seamless, black, ASTM A53/A53M, Type S, Grade B			4	Steel Pipe:
5	Seamless red brass pipe, ASTM B43	X	X		X
6	Bronze flanged fittings, ASME B16.24 for use with Items 5 and 7	X	X		X

TABLE II					
PIPE AND FITTING MATERIALS FOR PRESSURE PIPING SYSTEMS					
Item #	Pipe and Fitting Materials	SERVICE A	SERVICE B	SERVICE C	SERVICE D
7	Seamless copper pipe, ASTM B42	X	X		X
8	Seamless copper water tube, ASTM B88, ASTM B88M	X**	X**	X**	X***
9	Cast bronze threaded fittings, ASME B16.15 for use with Items 5 and 7	X	X		X
10	Wrought copper and bronze solder-joint pressure fittings, ASME B16.22 for use with Items 5, 7 and 8	X	X	X	X
11	Cast copper alloy solder-joint pressure fittings, ASME B16.18 for use with Item 8	X	X	X	X
21	Fittings: brass or bronze; ASME B16.15, and ASME B16.18 ASTM B828	X	X		
22	Carbon steel pipe unions, socket-welding and threaded, MSS SP-83			X	
23	Nipples, pipe threaded ASTM A733			X	
	SERVICE: A - Cold Water Service Aboveground B - Hot and Cold Water Distribution 180 degrees F Maximum Aboveground C - Compressed Air Lubricated D - Cold Water Service Belowground Indicated types are minimum wall thicknesses. ** - Type L - Hard *** - Type K - Hard temper with brazed joints only or type K-soft temper without joints in or under floors **** - In or under slab floors only brazed joints				

-- End of Section --

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SEISMIC BRACING FOR HVAC

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SEISMIC BRACING FOR HVAC
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 355.2	(2007) Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary
ACI 355.4	(2011) Qualification of Post-Installed Adhesive Anchors in Concrete (ACI 355.4) and Commentary

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C105/A21.5	(2018) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C116/A21.16	(2015) Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray Iron Fittings
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C213	(2022) Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A603	(2019) Standard Specification for Zinc-Coated Steel Structural Wire Rope
ASTM D1785	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2665	(2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM E488/E488M	(2022) Standard Test Methods for Strength of Anchors in Concrete Elements
ASTM F891	(2016) Standard Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

FEMA P-414	(January 2004) Installing Seismic Restraints for Duct and Pipe

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC ES AC156	(2012) Acceptable Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components
ICC ES AC193	(2012) Acceptance Criteria for Mechanical Anchors in Concrete Elements

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

METAL FRAMING MANUFACTURERS ASSOCIATION (MFMA)

MFMA-4	(2004) Metal Framing Standards Publication

NSF INTERNATIONAL (NSF)

NSF/ANSI 61	(2022) Drinking Water System Components - Health Effects

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-301-02	(2023) Design of Risk Category V Structures, National Strategic Military Assets
UFC 4-010-01	(2018; with Change 3, 2024) DoD Minimum Antiterrorism Standards for Buildings

VIBRATION ISOLATION AND SEISMIC CONTROL MANUFACTURERS ASSOCIATION (VISCMA)

VISCMA 412	(2014) Installing Seismic Restraints for Mechanical Equipment

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Apply the requirements for seismic protection measures described in this section and on the drawings to the mechanical equipment and mechanical systems both inside and outside of the building along with exterior utilities and systems listed below. Where there is a conflict between the specifications and the drawings, the specifications will take precedence. Accomplish resistance to lateral forces induced by earthquakes without consideration of friction resulting from gravity loads.

1.2.2 Mechanical Equipment

Mechanical equipment to be seismically protected must include the following items to the extent required on the drawings or in other sections of these specifications:

Mission Critical Level 1 (MC-1) Equipment/Components in Risk Category V designed in accordance with UFC 3-301-02:

Boilers and furnaces	Storage Tanks for Oil and Water
Water Heaters	
Expansion Air Separator Tanks	Valves and Fittings for Piping
Heat Exchangers	Steam-fed Kitchen Appliances
Water Chiller Units	Thermal Storage Units
Cooling Towers, Evaporative Coolers, and Fluid Coolers	Air and Refrigerant Compressors
Computer Room Air Conditioners	Air Handling Units
Pumps with Motors	Lab Scrubbers
Large Commercial Dryers	Pollution Control Equipment
Gas Dryers	Split System DX Units
Flash Tanks	Unit Heaters
Accumulator Tank	Exhaust, Return and Misc. Fans
Gas Cylinders	Solar Heating and Hot Water Units
Bridge Cranes and Monorails	Pumps
Air Terminal Units	Unitary HVAC Systems
Humidifiers	Fan Coil Units
Stacks	Instrumentation and Control for HVAC
Duct Mounted Coils	Duct Silencers

1.2.3 Mechanical Systems

Mechanical systems to be seismically protected must include the following items to the extent required on the drawings or in this or other sections of these specifications:

Mission Critical Level 1 (MC-1) Mechanical Systems in Risk Category V designed in accordance with UFC 3-301-02.

a. All Piping and Ducts Inside the Building Except as Specifically Stated Below Under "Items Not Covered By This Section".

b. Chilled Water Distribution Systems Outside of Buildings.

c. Steam, Water, Oil, Gas and Fuel Piping Outside of Buildings.

d. All Water Supply Systems Outside of Buildings.

e. Storm and Sanitary Sewer Systems Outside of Buildings.

f. All Process Piping Outside of Buildings.

g. Heat Distribution Systems (Supply, Return, and Condensate Return) Outside of Buildings.

h. Condenser Water and Refrigerant Piping Outside the Building.

i. Pneumatic Tube Distribution System Outside of Buildings.

j. Cold Storage Refrigeration Systems Outside of Buildings.

k. Fuel Storage Tanks Outside of Buildings.

l. Water Storage Tanks Outside of Buildings.

m. Ductwork Outside of Buildings.

n. Stacks.

1.2.4 Contractor Designed Bracing

Submit copies of the design calculations with the drawings. Calculations must be approved, certified, stamped and signed by a registered Professional Structural Engineer. Calculations must verify the capability of structural members to which bracing is attached for carrying the load from the brace. Design the bracing in accordance with UFC 3-301-01, UFC 3-301-02, UFC 4-010-01 and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes must be accomplished without consideration of friction resulting from gravity loads. UFC 3-301-01 uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas must be required. Loadings determined using UFC 3-301-01 are based on strength design; therefore, AISC 325 Specifications must be used for the design. The bracing for the mechanical equipment designated in paragraph 1.2.2 and systems designated in paragraph 1.2.3 must be developed by the Contractor.

Provide documentation of an independent design review for mission critical (MC) equipment bracing design. Documentation must be signed by the independent reviewer who must also be a registered structural engineer.

1.2.5 Items Not Covered By This Section

1.2.5.1 Items Requiring No Seismic Restraints

Seismic restraints are not required for the following items:

a. Gas piping less than 1 inch nominal pipe size.

b. Piping in boiler and mechanical equipment rooms less than 1-1/4 inches nominal pipe size.

c. All other piping equal to or less than 3inches nominal pipe size.

d. Rectangular air handling ducts less than 6 square feet in cross sectional area.

e. Round air handling ducts less than 28 inches in diameter.

f. Piping suspended by individual hangers 12 inches or less in length from the top of pipe to the bottom of the supporting structural member where the hanger is attached, except as noted below.

g. Ducts suspended by hangers 12 inches or less in length from the top of the duct to the bottom of the supporting structural member, except as noted below.

In exemptions f. and g. all hangers must meet the length requirements. If the length requirement is exceeded by one hanger in the run, brace the entire run. Seismically protect interior piping and ducts not listed above in accordance with the provisions of this specification.

Non-critical items may require seismic restraints if adjacent to critical equipment or systems that must remain operational after an earthquake and could be compromised by impact with non-critical adjacent components.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Coupling and Bracing

Flexible Couplings or Joints

Equipment Restraint

Contractor Designed Bracing; G, DO

SD-03 Product Data

Coupling and Bracing; G, DO

Flexible Couplings Or Joints;

Equipment Restraint; G, DO

Contractor Designed Bracing; G, DO

Snubbers

Anchor Bolts

Vibration Isolators

SD-05 Design Data

Design Calculations

SD-06 Test Reports

Anchor Bolts; G, DO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

PART 2 PRODUCTS

2.1 GENERAL DESIGN REQUIREMENTS

Submit detailed seismic restraint drawings for mechanical equipment, duct systems, piping systems and any other mechanical systems along with calculations, catalog cuts, templates, and erection and installation details, as appropriate, for the items listed below. Indicate thickness, type, grade, class of metal, and dimensions; and show construction details, reinforcement, anchorage, and installation with relation to the building construction. Calculations must be stamped, by a registered structural engineer, and verify the capability of structural members to which bracing is attached for carrying the load from the brace. Include drawing for Mission Critical Equipment indicating the equipment location in the facility sufficient to be used for the installation. Design must be based on actual equipment and system layout. Design must include calculated dead loads, static seismic loads and capacity of materials utilized for the connection of the equipment or system to the structure. Analysis must detail anchoring methods.

2.2 EQUIPMENT RESTRAINT

Equipment must be rigidly or flexibly mounted as indicated in the specifications and/or drawings depending on vibration isolation requirements as follows below.

Roof mounted equipment such as cooling towers and condensers, both vibration isolated and nonisolated, must have support members designed and anchored to building structural steel or concrete as required for seismic restraint and wind loads.

2.2.1 Rigidly (Base and Suspended) Mounted Equipment

HVAC equipment furnished under this contract must be rigidly mounted using cast-in-place anchor bolts or post-installed anchors that are qualified for earthquake loading in accordance with ACI 355.2 and ACI 355.4. Anchor bolts must conform to ASTM F1554. For any rigid equipment which is rigidly anchored, provide flexible joints for piping, ductwork, electrical conduit, etc., that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions. Suspended equipment bracing attachments should be located just above the center of gravity to minimize swinging. Use the ratio of the overturning moment from seismic forces to the resisting moment due to gravity loads to determine if overturning forces need to be considered in the sizing of anchor bolts. Provide calculations to verify the adequacy of the anchor bolts for combined shear and overturning.

Roof mounted HVAC equipment roof curbs, framing and attachment to

equipment and structure must be designed and braced to withstand seismic loads. Mission critical base mounted and suspended equipment for Risk Category (RC) V, Designated Seismic Systems (DSS) assigned to Seismic Design Category (SDC) C, D, E, or F and Risk Category IV components needed for continued operation after an earthquake must have two nuts provided on each anchor bolt.

2.2.2 Nonrigid or Flexibly-Mounted Equipment

Select vibration isolation devices so that the maximum movement of equipment from the static deflection point is 1/4 inch. Equipment flexibly mounted on vibration isolators must have a bumper restraint or snubber in each horizontal direction and vertical restraints must be provided where required to resist overturning. Isolator housing and restraints must be constructed of ductile materials. A viscoelastic pad or similar material of appropriate thickness must be used between the bumper and components to limit the impact load. Restraints must be designed to resist the calculated horizontal lateral and vertical forces.

Spring vibration isolators must be seismically rated, restrained isolators for equipment subject to load variations and large external forces. The seismically rated housing must be sized to meet or exceed the force requirements applicable to the project and meet the required isolation criteria. Spring vibration isolator manufacturer's will be a member of VISCMA. Design force, Fp, must be doubled for vibration isolators with an air gap greater than 0.25 inches as specified in ASCE 7-16, Chapter 13. Housed springs must not be used for seismic restraint applications because they cannot resist uplift.

2.3 BOLTS AND NUTS

Hex head bolts, and heavy hexagon nuts must be ASTM A325 or ASTM A490 bolts and ASTM A563 nuts. Provide bolts and nuts galvanized in accordance with ASTM A153/A153M when used underground or exposed to weather.

2.4 FLEXIBLE JOINTS

Flexible joints must have same pressure and temperature ratings as adjoining pipe. Braided hoses must not be used where there is torsional or axial movement unless manufacturer allows it.

2.4.1 Braided Hose Expansion Joint

Braided hose expansion joint(s) must be installed in the locations indicated on the drawings and as required to accommodate any thermal expansion, contraction or seismic movement of the piping system. Joints must consist of two parallel sections of corrugated metal hose, compatible braid, and 180 degree return bend with inlet and outlet connections. Field fabricated loops are not acceptable. Braided hose expansion joint(s) must be installed in the locations indicated on the drawings and as required to accommodate any thermal expansion, contraction or seismic movement of the piping system. Joints must consist of two parallel sections of corrugated metal hose, compatible braid, and 180 degree return bend with inlet and outlet connections. Field fabricated loops must not be acceptable. Braided hose in a 60 degree flexible V loop arrangement must be used for small diameter pipe connections to coils in variable-air-volume (VAV)terminal units and fan coil units installed in suspended ductwork whether braced or unbraced.

All braided hose expansion joints must be manufactured in accordance with the documented manufacturers weld procedure specifications. The procedure qualification record must be used to document the execution of this procedure and must follow the general "guidelines" of ASME Section IX. Each individual welder must conform to the in-house procedure qualification record and be qualified prior to each production lot. The testing of each individual welder must be documented in a welding procedure qualification record.

2.4.1.1 Corrugated Hose

Corrugated hose must be Type 304 stainless steel . Braid must be Type 304 stainless steel for any series 300 stainless steel hose . Fittings materials of construction and end fitting type must be consistent with pipe material and equipment/ pipe connection fittings. Copper fittings must not be attached to stainless steel hose.

2.4.1.2 Flexible Hose Expansion Loops

Flexible hose expansion loops must have a factory supplied, hanger / support lug located at the bottom of the 180deg return. Flexible hose expansion loop(s) must be furnished with a plugged FPT to be used for a drain or air release vent. Flexible hose expansion loop(s) must be rated with an operating pressure which is the same as the adjoining pipe. The operating pressure must be based on burst pressure with a 4 to 1 safety factor. For steam service, the operating pressure must be based on burst pressure with a 8 to 1 safety factor.

2.4.2 Double Ball Flexible Expansion Joint

Install flexible expansion joints manufactured of ductile iron conforming to the material requirements of ASTM A536 and AWWA C153/A21.53 in the locations indicated on the drawings. Provide foundry certification of material upon request. Each flexible expansion joint must be pressure tested prior to shipment against its own restraint to a minimum of 350 psi (250 psi for flexible expansion joints 2 inch and 30 inches diameter and larger.) A minimum 2:1 safety factor, determined from the published pressure rating, must apply. Factory Mutual Approval for the 3 inch through 12 inch sizes is required. Each flexible expansion joint must consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20°, 2" - 12"; 15°, 14" - 36"; 12°, 42"-48" and 4-inches minimum expansion. Additional expansion sleeves must be available and easily added or removed at the factory or in the field. Both standardized mechanical joint and flange end connections must be available.

2.4.2.1 Internal Surfaces

Line all internal surfaces (wetted parts) with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213. Sealing gaskets must be constructed of EPDM. The coating must meet NSF/ANSI 61.

2.4.2.2 Exterior Surfaces

Coat exterior surfaces with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C116/A21.16. Include appropriately sized polyethylene sleeves, meeting AWWA C105/A21.5, for direct buried applications.

2.4.3 Double Ball Flexible Expansion Joint Gravity Drain (Non-Pressurized)

Flexible expansion joints gravity drain must be installed in the locations indicated on the drawings and must be manufactured of pvc. All connections whether solvent weld or mechanical must be restrained to allow movement to be transferred to expansion joint. Each ball must allow up to 15 degrees deflection.

End connection outside diameters must be compatible with ASTM D1785, ASTM D2665 and ASTM F891 PVC pipe and are to be solvent welded.

2.5 SWAY BRACING MATERIALS

Material used for members listed in this section and on the drawings, must be structural steel conforming with the following:

a. Plates, rods, and rolled shapes, ASTM A36/A36M.

b. Wire rope, ASTM A603 pre-stretched. Class B galv coating Ferrule clamps must be qualified by testing for use in seismic applications per VISCMA 412. A minimum of two clamps are required on each end of wire rope.

c. Tubes, ASTM A500/A500M, Grade B.

d. Pipes, ASTM A53/A53M, Grade B.

e. Angles, ASTM A36/A36M.

f. Channels (Struts) with in-turned lips and associated hardware for fastening to channels at random points conforming to MFMA-4

2.6 MULTIDIRECTIONAL SEISMIC SNUBBERS

Install multidirectional seismic snubbers employing elastomeric pads on floor- or slab-mounted equipment and large piping as detailed on drawings. These snubbers must provide 1/4 inch free vertical and horizontal movement from the static deflection point. Snubber medium must consist of multiple pads of cotton duct and neoprene or other suitable materials arranged around a flanged steel trunnion so both horizontal and vertical forces are resisted by the snubber medium.

PART 3 EXECUTION

3.1 COUPLING AND BRACING

a. Submit detail drawings, as specified here and throughout this specification, along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals must be complete in detail; must indicate thickness, type, grade, class of metal, and dimensions; and must show construction details, reinforcement, anchorage, and installation with relation to the building construction.

b. Provide coupling installation conforming to the details shown on the drawings. Provisions of this paragraph apply to all piping within a 5 foot line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers must be braced at

the most frequent interval as determined by applying the requirements of this specification to each piping run on the common support.

c. Size bracing components as required for the total load carried by the common supports. Bracing rigidly attached to pipe flanges, or similar, must not be used where it would interfere with thermal expansion of piping.

d. Adjust isolators and restraints after piping systems has been filled and equipment is at its operating weight, following the manufacturer's written instructions.

e. Install cables at a 45-degree slope. Where interference is present, the slope may be minimum of 30 degrees or a maximum of 60 degrees per VISCMA 412.

3.2 BUILDING DRIFT

Provide joints capable of accommodating seismic displacements for vertical piping between floors of the building, where pipes pass through a building seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators. Provide horizontal piping across expansion joints to accommodate the resultant of the drifts of each building unit in each orthogonal direction. For threaded piping, provide swing joints made of the same piping material. For piping with manufactured ball joints the seismic drift must be 0.015 feet per foot of height above the base where the seismic separation occurs; this drift value must be used in place of the expansion given in the manufacturer's selection table.

3.3 FLEXIBLE COUPLINGS OR JOINTS

3.3.1 Building Piping

Provide flexible couplings or joints in building piping at bottom of all pipe risers for pipe larger than 3-1/2 inches in diameter. Laterally brace flexible couplings or joints without interfering with the action of the flexible coupling or joint. Cast iron waste and vent piping need only comply with these provisions when caulked joints are used. Flexible bell and spigot pipe joints using rubber gaskets may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to satisfy these requirements.

3.3.2 Underground Piping

Install flexible coupling in underground piping and 4 inch or larger conduit, except heat distribution system, where the piping enters the building. Provide couplings that accommodate 1 inches of relative movement between the pipe and the building in any direction. Provide additional flexible couplings where shown on the drawings.

3.4 PIPE SLEEVES

Size pipe sleeves in interior non-fire rated walls as indicated on the drawings to provide clearances that will permit differential movement of piping without the piping striking the pipe sleeve. Pipe sleeves in fire rated walls must conform to the requirements in Section 07 84 00 FIRESTOPPING.

3.5 SPREADERS

Provide spreaders between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches apart. Apply spreaders at same interval as sway braces at an equal distance between the sway braces. If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack. Apply spreaders to surface of bare pipe and over insulation on insulated pipes utilizing high-density inserts and pipe protection shields in accordance with the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.6 SWAY BRACES FOR PIPING

Provide sway braces to prevent movement of the pipes under seismic loading. Provide braces in both the longitudinal and transverse directions, relative to the axis of the pipe. Provide sufficient braces for equipment to resist a horizontal force as specified in UFC 3-301-01 UFC 3-301-02 without exceeding safe working stress of bracing components. Provide bracing that does not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications. For seismic analysis of horizontal pipes, the equivalent static force should be considered to act concurrently with the full dead load of the pipe, including contents.

3.6.1 Transverse Sway Bracing

Provide transverse sway bracing for steel and copper pipe at intervals not to exceed those shown on the drawings. All runs (length of pipe between end joints) must have a minimum of transverse bracing at each end. Provide transverse sway bracing for pipes of materials other than steel and copper at intervals not to exceed the hanger spacing as specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.6.2 Longitudinal Sway Bracing

Provide longitudinal sway bracing at 40 foot intervals unless otherwise indicated. All runs (length of pipe between end joints) must have one longitudinal brace minimum. Construct sway braces in accordance with the drawings. Do not use branch lines, walls, or floors as sway braces.

3.6.3 Vertical Runs

Run is defined as length of pipe between end joints. Do not brace vertical runs of piping no more than 10 foot vertical intervals. Braces for vertical runs must be above the center of gravity of the segment being braced. Flexible couplings should be provided at the bottoms of risers for pipes larger than 3.5 in. (89 mm) in diameter. Flexible couplings and expansion joints should be braced laterally and longitudinally unless such bracing would interfere with the action of the couplings or joints. When pipes enter buildings, flexible couplings should be provided to allow for relative movement between the soil and building. Construct all sway braces in accordance with the drawings. Attach sway braces to the structural system. Do not connect to branch lines, walls, or floors.

3.6.4 Clamps and Hangers

Apply clamps or hangers on uninsulated pipes directly to pipe. Insulated piping must have clamps or hangers applied over insulation in accordance

with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

Hanger rod stiffener angle or strut bracing must be securely attached by a series of attachment clamps manufactured from a one piece metal stamping and must include all require attachment hardware and locking nuts. Attachment clamps made from aluminum or cast iron must not be used in seismic applications. Do not weld vertical braces to hanger rods.

3.7 SWAY BRACES FOR DUCTS

3.7.1 Braced Ducts

Provide bracing details and spacing for rectangular and round ducts in accordance with SMACNA 1981. However, the design seismic loadings for these items must not be less than loadings obtained using the procedures in UFC 3-301-01UFC 3-301-02. Bracing must not attach to duct joints. Use shortest screws possible when penetrating ductwork to minimize airflow noise inside duct.

3.7.2 Unbraced Ducts

Attach hangers for unbraced ducts to the duct within 2 inches of the top of the duct with a minimum of two #10 sheet metal screws in accordance with FEMA P-414. Use shortest screws possible when penetrating ductwork to minimize airflow noise inside duct. Install unbraced ducts with a 6 inch minimum clearance to vertical ceiling hanger wires.

3.8 EQUIPMENT

3.8.1 General

Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices allowing adequate edge distance and embedment depth for restraint anchor bolts. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Install neoprene grommet washers or till the gap with epoxy on equipment anchor bolts where clearance between anchor and equipment support hole exceeds 0.125 inches.

3.8.2 Controls

Ensure that controls for critical equipment that must remain operational after an earthquake are certified per paragraph 3.11 SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT and are served by emergency power as required.

3.9 ANCHOR BOLTS

3.9.1 Cast-in-Place Anchor Bolts

Use templates to locate cast-in-place bolts accurately and securely in formwork. Anchor bolts must have an embedded straight length equal to at least 12 times nominal diameter of the bolt. Anchor bolts that exceed the normal depth of equipment foundation piers or pads must either extend into concrete floor or the foundation or be increased in depth to accommodate bolt lengths.

3.9.2 Drilled-In Anchor Bolts

Drill holes with rotary impact hammer drills Drill bits must be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes must be drilled perpendicular to the concrete surface. Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the COR if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines. Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength. Perform anchor installation in accordance with manufacturer instructions.

3.9.2.1 Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors

Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque must be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor must be removed and replaced unless otherwise directed by the Engineer.

3.9.2.2 Cartridge Injection Adhesive Anchors

Where approved for seismic application, clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive must be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.

3.9.2.3 Capsule Anchors

Where approved for seismic application, perform drilling and setting operations in accordance with manufacturer instructions. Clean all holes to remove loose material and drilling dust prior to installation of adhesive. Remove water from drilled holes in such a manner as to achieve a surface dry condition. Capsule anchors must be installed with equipment conforming to manufacturer recommendations. Do not disturb or load anchors before manufacturer specified cure time has elapsed.

Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

3.10 ANCHOR BOLT TESTING

Test in place expansion and chemically bonded anchors not more than 24

hours after installation of the anchor, conducted by an independent testing agency; testing must be performed on random anchor bolts as described below.

3.10.1 Torque Wrench Testing

Perform torque wrench testing on not less than 50 percent of the total installed applied torque expansion anchors and at least one anchor for every piece of equipment containing more than two anchors. The test torque must equal the minimum required installation torque as required by the bolt manufacturer. Calibrate torque wrenches at the beginning of each day the torque tests are performed. Recalibrate torque wrenches for each bolt diameter whenever tests are run on bolts of various diameters. Apply torque between 20 and 100 percent of wrench capacity. Reach the test torque within one half turn of the nut, except for 3/8 inch sleeve anchors which must reach their torque by one quarter turn of the nut. If any anchor fails the test, test similar anchors not previously tested until 20 consecutive anchors pass. Failed anchors must be retightened and retested to the specified torque; if the anchor still fails the test it must be replaced.

3.10.2 Pullout Testing

Test expansion and chemically bonded anchors by applying a pullout load using a hydraulic ram attached to the anchor bolt. Testing must be in accordance with ASTM E488/E488M or ICC ES AC193. At least 10 percent of each type and size of anchors, but not less than 3 per day must be tested. Apply the load to the anchor without removing the nut; when that is not possible, the nut must be removed and a threaded coupler must be installed of the same tightness as the original nut. Check the test setup to verify that the anchor is not restrained from withdrawing by the baseplate, the test fixture, or any other fixtures. The support for the testing apparatus must be at least 1.5 times the embedment length away from the bolt being tested. Load each tested anchor to 1 times the design tension value for the anchor. The anchor must have no observable movement at the test load. If any anchor fails the test, similar type and size anchors not previously tested must be tested until 10 percent of those type consecutive anchors pass. Remove and replace failed anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout.

3.11 SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT

Equipment and components (including controls) designated as MC-1 (Mission Critical Level 1 Designated Seismic Systems required to remain operational after an earthquake will be seismic qualified by shake table testing conforming to ICC ES AC156 procedures. The manufacturer is to provide a certification by a fully qualified testing agency for the specific equipment and/or components. Prequalified certifications are acceptable unless noted otherwise. Seismic component qualification documentation for each piece of equipment must contain the information required in UFC 3-301-02, Section 2-17.2.5 Component Qualification Documentation.

Mechanical components that are required to be certified must bear permanent marking or nameplates constructed of a durable heat and water resistant material. Nameplates must be mechanically attached to such nonstructural components and placed on each component for clear identification. The nameplate must not be less than 5 inches x 7 inches with red letters 1 inch in height on a white background stating "Certified

Equipment." The following statement must be on the nameplate: "This equipment/component is certified. No modifications are allowed unless authorized in advance and documented in the Equipment Certification Documentation file." The nameplate must also contain the component identification number in accordance with the drawings/specifications and the O&M manuals.

3.12 SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS AND EQUIPMENT

Perform special inspections for seismic-resisting mechanical systems, equipment and components for structures assigned to Risk Category V; designated mechanical seismic systems and equipment per ICC IBC 1705.12.4; and plumbing and mechanical components per ICC IBC 1705.12.6. Periodic special inspections will be conducted on mechanical equipment as required by Section 1705.12 of the International Building Code and paragraph 2-5.4 of UFC 3-301-01. Provide a Statement of Special Inspections and Final Report in accordance with paragraph 2-2.4.3 of UFC 3-301-01.

-- End of Section --

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

11/15

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SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC
11/15

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(2002; 6th ed) National Standards for Total System Balance

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV	(2006) Procedural Standards for Measurements and Assessment of Sound and Vibration
NEBB PROCEDURAL STANDARDS	(2015) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780	(2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition
SMACNA 1858	(2004) HVAC Sound And Vibration Manual - First Edition

1.2 DEFINITIONS

a. AABC: Associated Air Balance Council

b. COTR: Contracting Officer's Technical Representative

c. DALT: Duct air leakage test

d. DALT'd: Duct air leakage tested

e. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling

f. NEBB: National Environmental Balancing Bureau

g. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement

reported on the TAB Report for a specific parameter."

h. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.

i. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.

j. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.

k. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).

l. TAB: Testing, adjusting, and balancing (of HVAC systems)

m. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed

n. TAB Agency: TAB Firm
r. TABB: Testing Adjusting and Balancing Bureau

1.2.1 Similar Terms

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	AABC Term	NEBB Term	TABB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems	International Standards for Environmental Systems Balance
TAB Specialist	TAB Engineer	TAB Supervisor	TAB Supervisor

SIMILAR TERMS			
Contract Term	AABC Term	NEBB Term	TABB Term
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures	Field Readiness Check & Prelim. Field Procedures

1.3 WORK DESCRIPTION

The work includes testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings.

Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

1.3.1 Air Distribution Systems

Test, adjust, and balance systems (TAB) in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to exterior of air distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.2 TAB SCHEMATIC DRAWINGS

Show the following information on TAB Schematic Drawings:

1. A unique number or mark for each piece of equipment or terminal.

2. Air quantities at air terminals.

3. Air flow measurements for all inline fans.

Submit three copies of the TAB Schematic Drawings and Report Forms to the Contracting Officer, no later than 21 days prior to the start of TAB field measurements.

1.3.3 Related Requirements

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms; G, RO

SD-03 Product Data

Equipment and Performance Data; G, RO

TAB Related HVAC Submittals; G, RO

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB team engineer .

SD-07 Certificates

Independent TAB Agency and Personnel Qualifications; G, RO

TAB Submittal and Work Schedule; G, RO

TAB Pre-Field Engineering Report; G, RO

1.5 QUALITY ASSURANCE

1.5.1 Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Contracting Officer for approval:

a. Independent AABC or NEBB or TABB TAB agency:

TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

TAB team field technicians: Names and documented evidence that

each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

b. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.

c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section.

3.2 PRE-TAB MEETING

Meet with the Contracting Officer's technical representative (COTR) to develop a mutual understanding relative to the details of the TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include TAB Related HVAC Submittals, tab submittal and work schedule, and field quality control.

3.3 TAB PROCEDURES

3.3.1 TAB Field Work

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.

That is, comply with the the requirements of AABC MN-1 or SMACNA 1780 (TABB) and SMACNA 1858 (TABB),except as supplemented and modified by this section.

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section.

3.3.2 Preliminary Procedures

Use the approved TAB pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

3.3.3 TAB Air Distribution Systems

3.3.3.1 Units With Coils

Report heating and cooling performance capacity tests for hot water, chilled water, DX and steam coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.3.4 Deficiencies

Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph WORKMANSHIP, provide written notice as soon as possible to the Contractor and the Contracting Officer describing the deficiency and recommended correction.

Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

3.3.5 TAB Reports

3.3.6 Quality Assurance - COTR TAB Field Acceptance Testing

3.3.6.1 TAB Field Acceptance Testing

During the field acceptance testing, verify, in the presence of the COTR, random selections of data (water, air quantities, air motion,) recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the COTR. Measurement and test procedures are the same as approved for TAB work for the TAB Report.

Field acceptance testing includes verification of TAB Report data recorded for the following equipment:

All supply fans and exhaust fans.

Further, if any data on the TAB Report is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the COTR. Verify TAB Report data for one additional piece of equipment. Continue this additional data verification until out-of-tolerance data ceases to be found.

3.3.6.2 Additional COTR TAB Field Acceptance Testing

If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the COTR.

3.3.6.3 Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Contracting Officer approval of the TAB Report submitted.

3.4 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

3.5 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

-- End of Section --

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SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A240/A240M	(2023) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C195	(2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C450	(2008) Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
ASTM C533	(2017; R 2023) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534/C534M	(2023) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	(2022a) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2022) Standard Specification for Cellular Glass Thermal Insulation
ASTM C591	(2022) Standard Specification for Unfaced

	Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C610	(2017; R 2023) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM C647	(2008; R 2013) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C755	(2019b) Standard Practice for Selection of Water Vapor Retarders for Thermal Insulation
ASTM C795	(2008; R 2023) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants
ASTM C921	(2010; R 2015) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C1126	(2018) Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C1136	(2023) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1710	(2011) Standard Guide for Installation of Flexible Closed Cell Preformed Insulation in Tube and Sheet Form
ASTM D882	(2012) Tensile Properties of Thin Plastic Sheeting
ASTM D2863	(2019) Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
ASTM D5590	(2017; R 2021) Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2024) Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

ASTM E2231	(2021) Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalg

GREEN SEAL (GS)

GS-36	(2013) Adhesives for Commercial Use

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 2758	(2014) Paper - Determination of Bursting Strength

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(8th Ed) National Commercial & Industrial Insulation Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2024) Standard for the Installation of Warm Air Heating and Air Conditioning Systems

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS	SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-3316	(1987; Rev C; Am 2 1990) Adhesives, Fire-Resistant, Thermal Insulation

MIL-A-24179	(1969; Rev A; Am 2 1980; Notice 1 1987; Notice 2 2020) Adhesive, Flexible Unicellular-Plastic Thermal Insulation
MIL-PRF-19565	(1988; Rev C) Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor-Barrier

UL SOLUTIONS (UL)

UL 94	(2023; Reprint May 2023) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 2818	(2022) GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings

1.2 SYSTEM DESCRIPTION

1.2.1 General

Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Furnish and install field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submit the three SD types, SD-02 Shop Drawings, SD-03 Product Data, and SD-08 Manufacturer's Instructions at the same time for each system.

SD-02 Shop Drawings

MICA Plates; G, RO

Pipe Insulation Systems and Associated Accessories

Duct Insulation Systems and Associated Accessories

SD-03 Product Data

Pipe Insulation Systems; G, RO

Duct Insulation Systems; G, RO

SD-04 Samples

Thermal Insulation; G, RO

Display Samples; G, RO

SD-08 Manufacturer's Instructions

Pipe Insulation Systems; G, RO

Duct Insulation Systems; G, RO

1.4 CERTIFICATIONS

1.4.1 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party programs that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

1.5 QUALITY ASSURANCE

1.5.1 Installer Qualification

Qualified installers will have successfully completed three or more similar type jobs within the last 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the manufacturer's unopened containers. Protect materials delivered and placed in storage from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Attach manufacturer's stamp or label giving the name of the manufacturer and brand, and a description of the material, date codes, and approximate shelf life (if applicable) to packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval. Insulation packages and containers must be asbestos free.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. Include the product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation. The product data must be copyrighted, have an identifying or publication number, and have

been published prior to the issuance date of this solicitation. Submit materials furnished under this section together in a booklet.

2.1.1 Insulation System

Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems that are located within, on, under, and adjacent to buildings; and for plumbing systems. Provide CFC and HCFC free insulation.

2.1.2 Surface Burning Characteristics

Unless otherwise specified, insulation must have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Determine flame spread, and smoke developed indexes, by ASTM E84 or UL 723. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Prepare and mount test specimens according to ASTM E2231.

2.2 MATERIALS

Provide insulation that meets or exceed the requirements of ASHRAE 90.1. Ensure insulation exterior is cleanable, grease resistant, non-flaking and non-peeling. Provide compatible materials that do not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Use materials on stainless steel surfaces meeting ASTM C795 requirements. Do not use calcium silicate on chilled or cold water systems. Use asbestos free materials. Provide product recognized under UL 94 (if containing plastic) and listed in FM APP GUIDE.

2.2.1 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants must meet limit requirements of "Other" category within SCAQMD Rule 1168 sealants table). Provide aerosol adhesives used on the interior of the building that meet either emissions requirements of CDPH SECTION 01350 (use the office or classroom requirements, regardless of space type) or VOC content requirements of GS-36.

2.2.1.1 Mineral Fiber Insulation Cement

Provide cement in accordance with ASTM C195.

2.2.1.2 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. To resist mold/mildew, use lagging adhesive meeting ASTM D5590 with 0 growth rating. Provide nonflammable and fire-resistant lagging adhesives that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Ensure adhesive is MIL-A-3316, Class 1, pigmented white and suitable for bonding fibrous glass cloth to faced

and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bonding glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or Class 2 for attaching fibrous glass insulation to metal surfaces. Apply lagging adhesives in strict accordance with the manufacturer's recommendations for pipe and duct insulation.

2.2.1.3 Contact Adhesive

Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Ensure adhesive does not adversely affect, initially or in service, the insulation to which it is applied, nor cause any corrosive effect on metal to which it is applied. Ensure that any solvent dispersing medium or volatile component of the adhesive has no objectionable odor and does not contain any benzene or carbon tetrachloride. Ensure dried adhesive does not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive must be nonflammable and fire resistant. Flexible Elastomeric Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product listed in FM APP GUIDE.

2.2.2 Caulking

ASTM C920, Type S, Grade NS, Class 25, Use A.

2.2.3 Corner Angles

Nominal 0.016 inch aluminum 1 by 1 inch with factory applied kraft backing. Aluminum must be ASTM B209, Alloy 3003, 3105, or 5005.

2.2.4 Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems in accordance with ASTM C1710. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor). For satisfactory performance, use properly installed protective vapor retarder/barriers and vapor stops on high relative humidity and below ambient temperature applications to reduce movement of moisture through or around the insulation to the colder interior surface.

2.2.5 Finishing Cement

ASTM C450: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must comply with ASTM C795.

2.2.6 Fibrous Glass Cloth and Glass Tape

Provide fibrous glass cloth, with 20X20 maximum mesh size, and glass tape with maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Provide tape consisting of 4 inch wide rolls. Provide Class 3 tape that is 4.5 ounces/square yard.

Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial additive.

2.2.7 Staples

Outward clinching type ASTM A167, Type 304 or 316 stainless steel.

2.2.8 Jackets

2.2.8.1 Aluminum Jackets

Provide aluminum jackets consisting of corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105. Do not use corrugated aluminum jacket outdoors. Aluminum jacket securing bands must be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands must be 2 by 0.016 inch aluminum matching jacket material. Ensure bands for insulation below ground are 3/4 by 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, use bands at the circumferential joints that are designed by the manufacturer to seal the joints and hold the jacket in place.

2.2.8.2 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers must have high impact strength, ultraviolet (UV) resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

2.2.8.3 Vapor Barrier/Weatherproofing Jacket

Provide laminated self-adhesive vapor barrier/weatherproofing jacket, greater than 3 plies standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive); with 0.0000 permeability when tested in accordance with ASTM E96/E96M, using the water transmission rate test method; heavy duty, white or natural; and UV resistant. Flexible Elastomeric exterior foam with factory applied, UV Jacket made with a cold weather acrylic adhesive. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and excellent Water Vapor Transmission (WVT) rate.

2.2.8.4 Vapor Barrier/Vapor Retarder

Apply the following criteria to determine which system is required.

a. On ducts, piping and equipment operating below 99 degrees F or located outside with a vapor barrier.

b. Install ducts, pipes and equipment that are located inside and that always operate above 99 degrees F with a vapor retarder where required as stated in paragraph VAPOR RETARDER REQUIRED.

2.2.9 Vapor Retarder Required

ASTM C921, Type I, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of

25 Beach units is acceptable. Minimum tensile strength, 35 pounds/inch width. ASTM C921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pounds/inch width. Use jackets on insulation exposed in finished areas that have white finish suitable for painting without sizing. Based on the application, insulation materials that require manufacturer or fabricator applied pipe insulation jackets are cellular glass, when all joints are sealed with a vapor barrier mastic, and mineral fiber. Ensure all non-metallic jackets have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible elastomerics require (in addition to vapor barrier skin) vapor retarder jacketing for high relative humidity and below ambient temperature applications.

2.2.9.1 White Vapor Retarder All Service Jacket (ASJ)

ASJ is for use on hot/cold pipes, ducts, or equipment indoors or outdoors if covered by a suitable protective jacket. Provide product which meets all physical property and performance requirements of ASTM C1136, Type I, except a minimum burst strength of 85 psi. ASTM D2863 Limited Oxygen Index (LOI) is a minimum of 31.

In addition, do not use paper or other moisture-sensitive material for the outer exposed surface or the inner-most surface contacting the insulation. Ensure the outer exposed surface is white and has an emittance no less than 0.80. Ensure the outer exposed surface is paintable.

2.2.9.2 Vapor Retarder/Vapor Barrier Mastic Coatings

2.2.9.2.1 Vapor Barrier

The vapor barrier must be self adhesive (minimum 2 mils adhesive, 3 mils embossed) greater than 3 plies standard grade, silver, white, black and embossed white jacket for use on hot/cold pipes. Ensure permeability is less than 0.02 when tested in accordance with ASTM E96/E96M. Provide products meeting UL 723 or ASTM E84 flame and smoke requirements and that are UV resistant.

2.2.9.2.2 Vapor Retarder

Provide fire and water resistant vapor retarder coating appropriately selected for either outdoor or indoor service. Color must be white. Ensure the water vapor permeance of the compound is in accordance with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions. Provide nonflammable, fire resistant coating. To resist mold/mildew, provide coating meeting ASTM D5590 with 0 growth rating. Ensure coating meets MIL-PRF-19565 Type II (if selected for indoor service) and is Qualified Products Database listed. Determine all other application and service properties pursuant to ASTM C647.

2.2.9.3 Laminated Film Vapor Retarder

ASTM C1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork; where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable. Provide vapor retarder with a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flexible Elastomeric exterior foam with factory applied UV

Jacket. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and an excellent WVT rate.

2.2.9.4 Polyvinylidene Chloride (PVDC) Film Vapor Retarder

Provide PVDC film vapor retarder with a maximum moisture vapor transmission of 0.02 perms, minimum puncture resistance of 150 Beach units, a minimum tensile strength in any direction of 30 lb/inch when tested in accordance with ASTM D882, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.9.5 Polyvinylidene Chloride Vapor Retarder Adhesive Tape

Requirements must meet the same as specified for Laminated Film Vapor Retarder above.

2.2.9.6 Vapor Barrier/Weather Barrier

Ensure the vapor barrier is greater than 3 ply self adhesive laminate -white vapor barrier jacket- superior performance (less than 0.0000 permeability when tested in accordance with ASTM E96/E96M). Provide vapor barrier meeting UL 723 or ASTM E84 25 flame and 50 smoke requirements; and UV resistant. Minimum burst strength 185 psi in accordance with ISO 2758. Tensile strength 68 lb/inch width (PSTC-1000). Provide tape as specified for laminated film vapor barrier above.

2.2.10 Vapor Retarder Not Required

ASTM C921, Type II, Class D, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable. Provide jacket with a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.11 Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2.12 Insulation Bands

Provide 1/2 inch wide; 26 gauge stainless steel insulation bands.

2.2.13 Sealants

Choose sealants from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Provide sealants with a maximum permeance of 0.02 perms based on Procedure B for ASTM E96/E96M, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3 PIPE INSULATION SYSTEMS

Conform insulation materials to Table 1 and minimum insulation thickness as listed in Table 2 and meet or exceed the requirements of ASHRAE 90.1. Limit pipe insulation materials to those listed herein and meeting the following requirements:

2.3.1 Aboveground Cold Pipeline (-30 to 60 deg. F)

Provide insulation for outdoor, indoor, exposed or concealed applications, as follows:

2.3.1.1 Cellular Glass

ASTM C552, Type II, and Type III. Supply the insulation from the fabricator with (paragraph WHITE VAPOR RETARDER ALL SERVICE JACKET (ASJ)) ASJ vapor retarder and installed with all longitudinal overlaps sealed and all circumferential joints ASJ taped or supply the insulation unfaced from the fabricator and install with all longitudinal and circumferential joints sealed with vapor barrier mastic.

2.3.1.2 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II. Type I, Grade 1 for tubular materials. Type II, Grade 1, for sheet materials. Ensure Type I and II have vapor retarder/vapor barrier skin on one or both sides of the insulation, and require an additional exterior vapor retarder covering for high relative humidity and below ambient temperature applications.

2.3.1.3 Mineral Fiber Insulation with Integral Wicking Material (MFIWM)

ASTM C547. Install in accordance with manufacturer's instructions. Do not use in applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

2.3.1.4 Polyisocyanurate Insulation

ASTM C591, Type I. Supply the insulation with a factory applied vapor retarder/barrier that complies with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation and all covering must pass the flame spread index of 25 and the smoke developed index of 50 when tested in accordance with ASTM E84.

2.3.2 Aboveground Hot Pipeline (Above 60 deg. F)

Provide insulation for outdoor, indoor, exposed or concealed applications meeting the following requirements. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.2.1 Mineral Fiber

ASTM C547, Types I, II or III, supply the insulation with manufacturer's recommended factory-applied jacket.

2.3.2.2 Calcium Silicate

ASTM C533, Type I indoor only, or outdoors above 250 degrees F pipe temperature. Supply insulation with the manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.2.3 Cellular Glass

ASTM C552, Type II and Type III. Supply the insulation with manufacturer's recommended factory-applied jacket.

2.3.2.4 Flexible Elastomeric Cellular Insulation

Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive, complying with ASTM C534/C534M, Grade 1, Type I or II to 220 degrees F service. Type I for tubular materials. Type II for sheet materials.

2.3.2.5 Phenolic Insulation

ASTM C1126 Type III to 250 degrees F service must comply with ASTM C795. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

2.3.2.6 Perlite Insulation

ASTM C610

2.3.2.7 Polyisocyanurate Insulation

ASTM C591, Type I. Supply the insulation with a factory applied vapor retarder/barrier that complies with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. The insulation and all covering must pass the flame spread index of 25 and the smoke developed index of 50 when tested in accordance with ASTM E84.

2.4 DUCT INSULATION SYSTEMS

2.4.1 Factory Applied Insulation

Provide factory-applied ASTM C552, cellular glass thermal or ASTM C534/C534M Grade 1, Type II, flexible elastomeric closed cell insulation according to manufacturer's recommendations for insulation with insulation manufacturer's standard reinforced fire-retardant vapor barrier, with identification of installed thermal resistance (R) value and out-of-package R value.

2.4.1.1 Rigid Insulation

Calculate the minimum thickness in accordance with ASHRAE 90.1.

2.4.1.2 Blanket Insulation

Calculate minimum thickness in accordance with ASHRAE 90.1.

2.4.2 Duct Insulation Jackets

2.4.2.1 All-Purpose Jacket

Provide insulation with insulation manufacturer's standard reinforced fire-retardant jacket with or without integral vapor barrier as required by the service. In exposed locations, provide jacket with a white surface suitable for field painting.

2.4.2.2 Metal Jackets

2.4.2.2.1 Aluminum Jackets

ASTM B209, Temper H14, minimum thickness of 27 gauge (0.016 inch), with

factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide smooth surface jackets for jacket outside dimension 8 inches and larger. Provide corrugated surface jackets for jacket outside dimension 8 inches and larger. Provide stainless steel bands, minimum width of 1/2 inch.

2.4.2.2.2 Stainless Steel Jackets

ASTM A167 or ASTM A240/A240M; Type 304, minimum thickness of 33 gauge (0.010 inch), smooth surface with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Provide stainless steel bands, minimum width of 1/2 inch.

2.4.2.3 Vapor Barrier/Weatherproofing Jacket

Provide vapor barrier/weatherproofing jacket that is laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive), heavy duty white or natural).

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

Apply insulation to unheated and uncooled piping and equipment. Do not compress flexible elastomeric cellular insulation at joists, studs, columns, ducts, and hangers. The insulation must not pull apart after a one hour period; replace any insulation found to pull apart after one hour.

3.1.1 Display Samples

Submit and display, after approval of materials, actual sections of installed systems, properly insulated in accordance with the specification requirements. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Identify each material used by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. The Contracting Officer will inspect display sample sections at the jobsite. Keep approved display sample sections on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

3.1.1.1 Pipe Insulation Display Sections

Include as a minimum an elbow or tee, a valve, dielectric waterways and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

3.1.1.2 Duct Insulation Display Sections

Display sample sections for rigid and flexible duct insulation used on the job. Use a temporary covering to enclose and protect display sections for

duct insulation exposed to weather

3.1.2 Installation

Except as otherwise specified, install material in accordance with the manufacturer's written instructions. Do not apply insulation materials until tests specified in other sections of this specification are completed. Remove material such as rust, scale, dirt and moisture from surfaces to receive insulation. Keep insulaton clean and dry. Do not remove insulation from its shipping containers until the day it is ready to use and return to like containers or equally protect from dirt and moisture at the end of each workday. Thoroughly clean insulation that becomes dirty prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, reject the insulation, and immediately remove from the jobsite. Stagger joints on multi layer insulation. Mix mineral fiber thermal insulating cement with demineralized water when used on stainless steel surfaces. Install insulation, jacketing and accessories in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

3.1.3 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING. The protection of ducts at point of passage through firewalls must be in accordance with NFPA 90A and/or NFPA 90B. All other penetrations, such as piping, conduit, and wiring, through firewalls must be protected with a material or system of the same hourly rating that is listed by UL, FM, or a NRTL.

3.1.4 Installation of Flexible Elastomeric Cellular Insulation

Install flexible elastomeric cellular insulation with seams and joints sealed with rubberized contact adhesive. Do not use flexible elastomeric cellular insulation on surfaces greater than 220 degrees F. Stagger seams when applying multiple layers of insulation. Protect insulation exposed to weather and not shown to have vapor barrier weatherproof jacketing with two coats of UV resistant finish or PVC or metal jacketing as recommended by the manufacturer after the adhesive is dry and cured.

3.1.4.1 Adhesive Application

Apply a brush coating of adhesive to both butt ends to be joined and to both slit surfaces to be sealed. Allow the adhesive to set until dry to touch but tacky under slight pressure before joining the surfaces. Ensure insulation seals at seams and joints are not capable of being pulled apart one hour after application. Replace insulation that can be pulled apart one hour after installation.

3.1.4.2 Adhesive Safety Precautions

Use natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices.

3.1.5 Welding

Welding is not permitted on piping, duct or without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.6 Pipes/Ducts/ That Require Insulation

Insulation is required on all pipes and ducts except for omitted items as specified.

3.2 PIPE INSULATION SYSTEMS INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

Install pipe insulation on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder/barrier, including straight runs, fittings and appurtenances unless specified otherwise. Install full length units of insulation using a single cut piece to complete a run. Do not use cut pieces or scraps abutting each other. Omit pipe insulation on the following:

a. Pipe used solely for fire protection.

b. Chromium plated pipe to plumbing fixtures. However, for fixtures used by the physically handicapped, insulate the hot water supply and drain, including the trap, where exposed.

c. Sanitary drain lines.

d. Air chambers.

e. Adjacent insulation.

f. ASME stamps.

g. Access plates of fan housings.

h. Cleanouts or handholes.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

Provide continuous pipe insulation through the sleeve.

Provide an aluminum jacket or vapor barrier/weatherproofing self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 ply standard grade, silver, white, black and embossed with factory applied moisture retarder over the insulation wherever penetrations require sealing.

3.2.1.2.1 Penetrate Interior Walls

Provide aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 2 mils adhesive, 3 mils embossed) less than 0.0000 permeability, greater than 3 plies standard grade, silver, white, black and embossed which extends 2 inches beyond either side of the wall and

secure on each end with a band.

3.2.1.2.2 Penetrating Floors

Extend the aluminum jacket from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

3.2.1.2.3 Penetrating Waterproofed Floors

Extend the aluminum jacket rom below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.

3.2.1.2.4 Hot Water Pipes Supplying Lavatories or Other Similar Heated Service

Terminate the insulation on the backside of the finished wall. Protect the insulation termination with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). Extend the coating out onto the insulation 2 inches and seal the end of the insulation. Overlap glass tape seams 1 inch. Caulk the annular space between the pipe and wall penetration with approved fire stop material. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. Ensure the escutcheon plate overlaps the wall penetration at least 3/8 inches.

3.2.1.2.5 Domestic Cold Water Pipes Supplying Lavatories or Other Similar Cooling Service

Terminate the insulation on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). Protect the insulation with two coats of weather barrier mastic (breather emulsion type weatherproof mastic impermeable to water and permeable to air) with a minimum total thickness of 1/16 inch. Extend the mastic out onto the insulation 2 inches and seal the end of the insulation. The annular space between the outer surface of the pipe insulation and caulk the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. Ensure the escutcheon plate overlaps the wall penetration by at least 3/8 inches.

3.2.1.3 Pipes Passing Through Hangers

Ensure insulation, whether hot or cold application, is continuous through hangers. Support all horizontal pipes 2 inches and smaller on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-58. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, install insulation inserts as specified below for piping larger than 2 inches, or factory insulated hangers (designed with a load bearing core) can be used.

3.2.1.3.1 Horizontal Pipes Larger Than 2 Inches at 60 Degrees F and Above

Supported on hangers in accordance with MSS SP-58, and Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.2.1.3.2 Horizontal Pipes Larger Than 2 Inches and Below 60 Degrees F

Supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-58. Install an insulation insert of cellular glass, prefabricated insulation pipe hangers, or perlite above 80 degrees F above each shield. Ensure insert covers no less than the bottom 180-degree arc of the pipe. Provide inserts that are the same thickness as the insulation, and extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. Ensure the insulation jacket is continuous over the wooden dowel, wooden block, or insulation insert.

3.2.1.3.3 Vertical Pipes

Supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-58 covering the 360-degree arc of the insulation. Install an insulation insert of cellular glass or calcium silicate between each shield and the pipe. Ensure the insert covers the 360-degree arc of the pipe. Provide inserts that are the same thickness as the insulation, and extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. Ensure the insulation jacket is continuous over the wooden dowel, wooden block, or insulation insert. Support the vertical weight of the pipe with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, support the weight of the pipe additionally with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. Use insulated hangers and seal the insulation jacket as indicated herein for anchors in a similar service.

3.2.1.3.4 Inserts

Covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, overlap the adjoining pipe jacket 1-1/2 inches, and seal as required for the pipe jacket. Use jacket material to cover inserts in flexible elastomeric cellular insulation conforming to ASTM C1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Use tubular form flexible elastomeric cellular pipe insulation for pipe sizes 6 inches and less. Grade 1, Do not stretch Type II sheet insulation used on pipes larger than 6 inches around the pipe. On pipes larger than 12 inches, adhere the insulation directly to the pipe on the lower 1/3 of the pipe. Stagger seams when applying multiple layers of insulation. Insulate sweat fittings with miter-cut pieces the same size as on adjacent piping. Insulate screwed fittings with sleeved fitting covers fabricated from miter-cut pieces and overlap and seal to the adjacent pipe insulation. Type II requires an additional exterior vapor retarder/barrier covering for high relative humidity and below ambient temperature applications.

3.2.1.5 Pipes in high abuse areas.

In all areas, utilize , aluminum or flexible laminate cladding (comprised of elastomeric, plastic or metal foil laminate) laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket, - less than 0.0000 permeability; (greater than 3 ply, standard grade, silver, white, black and embossed) aluminum jackets. Protect pipe insulation to the 6 foot level.

3.2.1.6 Pipe Insulation Material and Thickness

Pipe insulation materials must be as listed in Table 1 and must meet or exceed the requirements ofASHRAE 90.1.

TABLE 1

Insulation Material for Piping

Service					
	Material	Specification	Type	Class	VR/VB Req'd
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Hot Domestic Water Supply & Recirculating Piping (Max 200 F)					
	Mineral Fiber	ASTM C547	I	1	No

TABLE 1

Insulation Material for Piping

	Material	Specification	Type	Class	VR/VB Req'd
Service					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
Refrigerant Suction Piping (35 degrees F nominal)					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Cellular Glass	ASTM C552	II	1	Yes
Compressed Air Discharge, Steam and Condensate Return (201 to 250 Degrees F					
	Cellular Glass	ASTM C552	II		No
	Mineral Fiber	ASTM C547	I	1	No
	Calcium Silicate	ASTM C533	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
	Perlite	ASTM C610			No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I	2	No
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
Horizontal Roof Drain Leaders (Including Underside of Roof Drain Fittings)					
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
	Cellular Glass	ASTM C552	III		Yes
Condensate Drain Located Inside Building					
	Cellular Glass	ASTM C552	II	2	No
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No

TABLE 1

Insulation Material for Piping

Service

	Material	Specification	Type	Class	VR/VB Req'd

Note: VR/VB = Vapor Retarder/Vapor Barrier

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

Service

	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
Cold Domestic Water Piping, Makeup Water & Drinking Fountain Drain Piping						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Hot Domestic Water Supply & Recirculating Piping (Max 200 F)						
	Mineral Fiber	1	1	1	1.5	1.5
	Cellular Glass	1.5	1.5	1.5	2	2
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8
Service						
Refrigerant Suction Piping (35 degrees F nominal)						
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
Compressed Air Discharge, Steam and Condensate Return (201 to 250 Degrees F						
	Mineral Fiber	1.5	1.5	2	2	2
		1.5*	2*	2.5*	3*	3.5*
	Calcium Silicate	2.5	3	4	4	4.5
	Cellular Glass	2	2.5	3	3	3
	Perlite	2.5	3	4	4	4.5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A
Exposed Lavatory Drains, Exposed Domestic Water Piping & Drains to Areas for Handicapped Personnel						
	Flexible Elastomeric Cellular	0.5	0.5	0.5	0.5	0.5
Condensate Drain Located Inside Building						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
	Flexible Elastomeric Cellular	1	1	1	N/A	N/A

TABLE 2

Piping Insulation Thickness (inch)
Do not use integral wicking material in Chilled water applications exposed to outdoor ambient conditions in climatic zones 1 through 4.

Service						
	Material	Tube And Pipe Size (inch)				
		<1	1-<1.5	1.5-<4	4-<8	> or = >8

3.2.2 Aboveground Cold Pipelines

Insulate the following cold pipelines for minus 30 to plus 60 degrees F in accordance with Table 2 except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted. This includes but is not limited to the following:

a. Refrigerant suction lines.

b. Air conditioner condensate drains.

c. Exposed lavatory drains and domestic water lines serving plumbing fixtures for handicap persons.

d. Domestic cold and chilled drinking water.

3.2.2.1 Insulation Material and Thickness

Determine insulation thickness for cold pipelines using Table 2.

3.2.2.2 Factory or Field applied Jacket

Cover insulation with a factory applied vapor retarder jacket/vapor barrier or field applied seal welded PVC jacket or greater than 3 ply laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - less than 0.0000 permeability, standard grade, sliver, white, black and embossed for use with Mineral Fiber, Cellular Glass, and Phenolic Foam Insulated Pipe. For insulation inside the building, to be protected with an aluminum jacket or greater than 3 ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, Embossed Silver, White & Black, install the insulation and vapor retarder jacket as specified herein. Install the aluminum jacket or greater than 3 ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, White & Black, as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. Provide aluminum jackets or greater than 3 ply vapor barrier/weatherproofing self-adhesive (minimum 2 mils adhesive, 3 mils embossed) product, less than 0.0000 permeability, standard grade, embossed silver, white & black, for pipe insulation.

3.2.2.3 Installing Insulation for Straight Runs Hot and Cold Pipe

Apply insulation to the pipe with tight butt joints. Seal all butted joints and ends with joint sealant and seal with a vapor retarder coating, greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or PVDC adhesive tape.

3.2.2.3.1 Longitudinal Laps of the Jacket Material

Overlap not less than 1-1/2 inches. Provide butt strips 3 inches wide for circumferential joints.

3.2.2.3.2 Laps and Butt Strips

Secure with adhesive and staple on 4 inch centers if not factory self-sealing. If staples are used, seal in accordance with paragraph

STAPLES below. Note that staples are not required with cellular glass systems.

3.2.2.3.3 Factory Self-Sealing Lap Systems

May be used when the ambient temperature is between 40 and 120 degrees F during installation. Install the lap system in accordance with manufacturer's recommendations. Use a stapler only if specifically recommended by the manufacturer. Where gaps occur, replace the section or repair the gap by applying adhesive under the lap and then stapling.

3.2.2.3.4 Staples

Coat all staples, including those used to repair factory self-seal lap systems, with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - 0.0000 perm adhesive tape. Coat all seams, except those on factory self-seal systems, with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.5 Breaks and Punctures in the Jacket Material

Patch by wrapping a strip of jacket material around the pipe and secure it with adhesive, staple, and coat with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. Extend the patch not less than 1-1/2 inches past the break.

3.2.2.3.6 Penetrations Such as Thermometers

Fill the voids in the insulation and seal with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

3.2.2.3.7 Flexible Elastomeric Cellular Pipe Insulation

Install by slitting the tubular sections and applying them onto the piping or tubing. Alternately, whenever possible slide un-slit sections over the open ends of piping or tubing. Secure all seams and butt joints and seal with adhesive. When using self seal products, secure only the butt joints with adhesive. Push insulation on the pipe, never pulled. Stretching of insulation may result in open seams and joints. Clean cut all edges. Rough or jagged edges of the insulation are not be permitted. Use proper tools such as sharp knives. Do not stretch Grade 1, Type II sheet insulation around the pipe when used on pipe larger than 6 inches. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.2.4 Insulation for Fittings and Accessories

a. Butt pipe insulation tightly to the insulation of the fittings and accessories. Seal the butted joints and ends with joint sealant and seal with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

b. Place precut or preformed insulation around all fittings and accessories and conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation must be the same insulation as the

pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Use insulation of the same thickness and conductivity as the adjoining pipe insulation. If nesting size insulation is used, overlap the insulation 2 inches or one pipe diameter. Elbows insulated using segments must conform to MICA Tables 12.20 "Mitered Insulation Elbow'. Submit a booklet containing completed MICA Insulation Stds plates detailing each insulating system for each pipe, duct, insulating system, after approval of materials and prior to applying insulation.

(1) Ensure MICA plates detail the materials to be installed and the specific insulation application. Submit all MICA plates required showing the entire insulating system, including plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. Present all variations of insulation systems including locations, materials, vaporproofing, jackets and insulation accessories.

(2) If the Contractor elects to submit detailed drawings instead of edited MICA Plates, ensure the detail drawings are technically equivalent to the edited MICA Plate submittal.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers must be protected with PVDC or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Overlap tap seams 1 inch. Extend the coating out onto the adjoining pipe insulation 2 inches. Protect fabricated insulation with a factory vapor retarder jacket with either greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape, standard grade, silver, white, black and embossed or PVDC adhesive tape or two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, seal the joints with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

d. Insulate anchors attached directly to the pipe for a sufficient distance to prevent condensation but no less than 6 inches from the insulation surface.

e. Mark insulation to show the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Use factory precut or premolded insulation segments under the fitting covers for elbows. Use insulation segmentswhich are the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. Secure the covers by PVC vapor retarder tape, adhesive, seal welding or with tacks made for securing PVC covers. Seal seams in the cover, and tacks and laps to adjoining pipe insulation jacket, with vapor retarder tape to ensure that the assembly has a continuous vapor

seal.

3.2.3 Aboveground Hot Pipelines

3.2.3.1 General Requirements

Insulate all hot pipe lines above 60 degrees F, except those piping listed in subparagraph Pipe Insulation in PART 3 as to be omitted, in accordance with Table 2. This includes but is not limited to the following:

a. Domestic hot water supply & re-circulating system.

b. Condensate & compressed air discharge.

c. Hot water heating.

Cover insulation, in accordance with manufacturer's recommendations, with a factory applied Type I jacket or field applied aluminum where required or seal welded PVC.

3.2.3.2 Insulation for Fittings and Accessories

Butt pipe insulation tightly to the insulation of the fittings and accessories. Seal butted joints and ends with joint sealant. Mark insulation to show the location of unions, strainers, check valves and other components that would otherwise be hidden from view by the insulation.

3.2.3.2.1 Precut or Preformed

Place precut or preformed insulation around all fittings and accessories. Use the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity.

3.2.3.2.2 Rigid Preformed

Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Use insulation that is the same thickness and conductivity as the adjoining pipe insulation. If nesting size insulation is used, do not overlap insulation 2 inches or one pipe diameter. Elbows insulated using segments must conform to MICA Tables 12.20 "Mitered Insulation Elbow".

3.3 DUCT INSULATION SYSTEMS INSTALLATION

Install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacket.

3.3.1 Duct Insulation Minimum Thickness

Duct insulation minimum thickness in accordance with Table 4.

Table 4 - Minimum Duct Insulation (inches)	
Cold Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5
Warm Air Ducts	2.0
Relief Ducts	1.5
Fresh Air Intake Ducts	1.5

3.3.2 Insulation and Vapor Retarder/Vapor Barrier for Cold Air Duct

Provide insulation and vapor retarder/vapor barrier for the following cold air ducts and associated equipment.

a. Supply ducts.

b. Return air ducts.

c. Relief ducts.

d. Flexible run-outs (field-insulated).

e. Plenums.

f. Duct-mounted coil casings.

g. Coil headers and return bends.

h. Coil casings.

i. Fresh air intake ducts.

j. Filter boxes.

k. Mixing boxes (field-insulated).

l. Supply fans (field-insulated).

m. Site-erected air conditioner casings.

n. Ducts exposed to weather.

o. Combustion air intake ducts.

Use insulation for rectangular ducts that is flexible type where concealed, minimum density 3/4 pcf, and rigid type where exposed, minimum density 3 pcf. Provide insulation for both concealed or exposed round/oval ducts that is flexible type, minimum density 3/4 pcf or a semi rigid board, minimum density 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered. Provide insulation for all exposed ducts with either a white, paint-able, factory-applied Type I jacket or a field applied vapor retarder/vapor barrier jacket coating finish as specified. Ensure the total field applied dry film

thickness is approximately 1/16 inch. Provide insulation on all concealed duct with a factory-applied Type I or II vapor retarder/vapor barrier jacket. Continue duct insulation through sleeves and prepare openings except firewall penetrations. Duct insulation terminating at fire dampers, must be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Provide duct insulation and vapor retarder/vapor barrier to cover the collar, neck, and un-insulated surfaces of diffusers, registers and grills. Apply vapor retarder/vapor barrier materials to form a complete unbroken vapor seal over the insulation. Seal sheet metal duct in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

3.3.2.1 Installation on Concealed Duct

a. For rectangular, oval or round ducts, attach flexible insulation by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts, 24 inches and larger, additionally secure insulation to bottom of ducts using mechanical fasteners. Space fasteners on 16 inch centers and no more than 16 inches from duct corners.

c. For rectangular, oval and round ducts, provide mechanical fasteners on sides of duct risers for all duct sizes. Space fasteners on 16 inch centers and no more than 16 inches from duct corners.

d. Impale insulation on the mechanical fasteners (self stick pins) where used and press thoroughly into the adhesive. Take care to ensure vapor retarder/vapor barrier jacket joints overlap 2 inches. Do not compress insulation to a thickness less than that specified. Carry insulation over standing seams and trapeze-type duct hangers.

e. Where mechanical fasteners are used, install self-locking washers and trim and bend the pin over.

f. Secure jacket overlaps with staples and tape as necessary to ensure a secure seal. Coat staples, tape and seams with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

g. Cover breaks in the jacket material with patches of the same material as the vapor retarder jacket. Do not extend patches less than 2 inches beyond the break or penetration in all directions and secure with tape and staples. Seal staples and tape joints with a brush coat of vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

h. At jacket penetrations such as hangers, thermometers, and damper operating rods, fill voids in the insulation and seal the penetration with a brush coat of vapor retarder coating or PVDC adhesive tape greater than 3 ply laminate (minimum 2 mils adhesive, 3 mils embossed) - less than 0.0000 perm adhesive tape.

i. Seal insulation terminations and pin punctures and flash with a reinforced vapor retarder coating finish or tape with a brush coat of

vapor retarder coating.. Ensure the coating overlaps the adjoining insulation and un-insulated surface 2 inches. Extend pin puncture coatings 2 inches from the puncture in all directions.

j. Where insulation standoff brackets occur, extend insulation under the bracket and terminate the jacket at the bracket.

3.3.2.2 Installation on Exposed Duct Work

a. For rectangular ducts, secure rigid insulation to the duct by mechanical fasteners on all four sides of the duct, space no more than 12 inches apart and no more than 3 inches from the edges of the insulation joints. Provide a minimum of two rows of fasteners for each side of duct 12 inches and larger. Provide one row for each side of duct less than 12 inches. Provide mechanical fasteners that are corrosion resistant as G60 coated galvanized steel, and indefinitely sustain a 50 lb tensile dead load test perpendicular to the duct wall.

b. Form duct insulation with minimum jacket seams. Fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, bring insulation up to standing seams, reinforcing, and other vertical projections and do not carry over. Continue vapor retarder/barrier jacket across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, carry over insulation and jacket . Apply insulation with joints tightly butted. Neatly bevel insulation around name plates and access plates and doors.

c. Impale insulation on the fasteners; install self-locking washers and trim and bend the pin over.

d. Seal joints in the insulation jacket with a 4 inch wide strip of tape. Seal taped seams with a brush coat of vapor retarder coating.

e. Cover breaks and ribs or standing seam penetrations in the jacket material with a patch of the same material as the jacket. Do not extend patches less than 2 inches beyond the break or penetration and secure with tape and staple. Seal staples and joints with a brush coat of vapor retarder coating.

f. At jacket penetrations such as hangers, thermometers, and damper operating rods, fill the voids in the insulation and seal the penetrations with a flashing sealant.

g. Seal and flash insulation terminations and pin punctures with a reinforced vapor retarder coating finish. Ensure coating overlaps the adjoining insulation and un-insulated surface 2 inches. Extend pin puncture coatings 2 inches from the puncture in all directions.

h. Insulate oval and round ducts, flexible type, with factory Type I jacket insulation with minimum density of 3/4 pcf, attach in accordance with MICA standards.

3.3.3 Insulation for Warm Air Duct

Provide insulation and vapor barrier for the following warm air ducts and associated equipment:.

a. Supply ducts.

b. Return air ducts.

c. Relief air ducts

d. Flexible run-outs (field insulated).

e. Plenums.

f. Duct-mounted coil casings.

g. Coil-headers and return bends.

h. Coil casings.

i. Fresh air intake ducts.

j. Filter boxes.

k. Mixing boxes.

l. Supply fans.

m. Site-erected air conditioner casings.

n. Ducts exposed to weather.

o. Exhaust ducts passing through concealed spaces exhausting conditioned air.

Provide insulation for rectangular ducts that is flexible type where concealed, and rigid type where exposed. Provide insulation on exposed ducts with a white, paint-able, factory-applied Type II jacket, or finish with adhesive finish. Use flexible type insulation for round ducts, with a factory-applied Type II jacket. Provide insulation on concealed duct with a factory-applied Type II jacket. Accomplish adhesive finish where indicated to be used by applying two coats of adhesive with a layer of glass cloth embedded between the coats. Ensure total dry film thickness is approximately 1/16 inch. Continue duct insulation through sleeves and prepare openings. Terminate duct insulation at fire dampers and flexible connections.

3.3.3.1 Installation on Concealed Duct

a. For rectangular, oval and round ducts, attach insulation by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts 24 inches and larger, secure insulation to the bottom of ducts using mechanical fasteners. Space fasteners on 18 inch centers and no more than 18 inches from duct corner.

c. For rectangular, oval and round ducts, provide mechanical fasteners on sides of duct risers for all duct sizes. Space fasteners on 18 inch centers and no more than 18 inches from duct corners.

d. Impale insulation on the mechanical fasteners where used. Do not compress insulation to a thickness less than that specified. Carry insulation over standing seams and trapeze-type hangers.

e. Install self-locking washers where mechanical fasteners are used and trim and bend the pin over.

f. Do not overlap insulatio jacket less than 2 inches at joints and secure the lap and staple on 4 inch centers.

3.3.3.2 Installation on Exposed Duct

a. For rectangular ducts, secure the rigid insulation to the duct using mechanical fasteners on all four sides of the duct, space no more than 16 inches apart and no more than 6 inches from the edges of the insulation joints. Provide a minimum of two rows of fasteners for each side of duct 12 inches and larger and a minimum of one row for each side of duct less than 12 inches.

b. Form duct insulation with factory-applied jacket with minimum jacket seams, and fasten each piece of rigid insulation to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, bring insulation up to standing seams, reinforcing, and other vertical projections and do not carry over the projection. Continue jacket across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, carry insulation and jacket over the projection.

c. Impale insulation on the fasteners; install self-locking washers and trim and bend the pin over.

d. Seal joints on jacketed insulation with a 4 inch wide strip of tape and brush with vapor retarder coating.

e. Cover breaks and penetrations in the jacket material with a patch of the same material as the jacket. Extend patches no less than 2 inches beyond the break or penetration and secure with adhesive and staple.

f. Seal insulation terminations and pin punctures with tape and brush with vapor retarder coating.

g. Insulate oval and round ducts, flexible type, with factory Type I jacket insulation, minimum density of 3/4 pcf attach by staples spaced no more than 16 inches and no more than 6 inches from the degrees of joints. Seal joints in accordance with item "d." above.

3.3.4 Ducts Handling Air for Dual Purpose

For air handling ducts for dual purpose below and above 60 degrees F, insulate ducts as specified for cold air duct.

3.3.5 Insulation for Evaporative Cooling Duct

Insulate evaporative cooling supply duct located in spaces not evaporatively cooled. Use material and installation requirements as specified for duct insulation for warm air duct.

3.3.6 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, repair breaks in the insulation and jacket in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.3.7 Duct Exposed to Weather

3.3.7.1 Installation

Insulate and finish ducts exposed to weather as specified for the applicable service for exposed duct inside the building. After the above is accomplished, further finish the insulation as detailed in the following subparagraphs.

3.3.7.2 Round Duct

Laminated self-adhesive (minimum 2 mils adhesive, 3 mils embossed) vapor barrier/weatherproofing jacket - Less than 0.0000 permeability, (greater than 3 ply, standard grade, silver, white, black and embossed or greater than 8 ply, heavy duty, white and natural) membrane must be applied overlapping material by 3 inches no bands or caulking needed - see manufacturer's recommended installation instructions. Aluminum jacket with factory applied moisture retarder must be applied with the joints lapped no less than 3 inches and secured with bands located at circumferential laps and at no more than 12 inch intervals throughout. Lap horizontal joints down to shed water and located at 4 or 8 o'clock position. Seal joints with metal jacketing sealant to prevent moisture penetration. Where jacketing abuts an un-insulated surface, seal joints with metal jacketing sealant.

3.3.7.3 Fittings

Finish fittings and other irregular shapes as specified for rectangular ducts.

3.3.7.4 Rectangular Ducts

Apply two coats of weather barrier mastic reinforced with fabric or mesh for outdoor application to the entire surface. Ensure each coat of weatherproof mastic has a minimum thickness of 1/16 inch. Ensure exterior is a metal jacketing applied for mechanical abuse and weather protection, and secure with screws or vapor barrier/weatherproofing jacket less than 0.0000 permeability greater than 3 ply, standard grade, silver, white, black, and embossed or greater than 8 ply, heavy duty white and natural. Apply membrane overlapping material by 3 inches. No bands or caulking needed-see manufacturing recommend installation instructions.

-- End of Section --

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SECTION 23 08 00

COMMISSIONING OF MECHANICAL AND PLUMBING SYSTEMS
05/23, CHG 1: 08/24

PART 1 GENERAL

Building Commissioning is a systematic, quality-focused process for enhancing the delivery of a project that focuses on verifying and documenting that all of the commissioned systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the project requirements. The purpose is to reduce the cost and performance risks associated with delivering facilities projects, and to increase value to owners, occupants, and users. Comply with specification Section 01 91 00.15 BUILDING COMMISSIONING.

1.1 SEQUENCING AND SCHEDULING

Complete the following prior to starting Functional Performance Tests of mechanical systems:

a. All equipment and systems completed, cleaned, flushed, disinfected, calibrated, tested, and operate in accordance with contract documents and construction plans and specifications

b. Pre-final Testing, Adjusting, and Balancing Report submitted in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC

d. Performance Verification Tests of the controls systems have been completed and the Performance Verification Test Report has been submitted and approved in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

e. The Certificate of Readiness submitted and approved in accordance with Section 01 91 00.15 BUILDING COMMISSIONING

g. Tests, Flushing, and Disinfection in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Test Equipment;

SD-06 Test Reports

Pipe Flushing, Testing, And Water Treatment Reports; G, RO

Completed Pre-Functional Checklists; G, RO

Post-Construction Trend Log Report; G, RO

SD-07 Certificates

Certificate Of Readiness; G, RO

1.3 ACCESSIBILITY REQUIREMENTS

Equipment, systems, and devices for commissioned systems must be accessible. Make necessary modifications if systems and devices are not accessible for inspections and testing.

Assist commissioning team in testing by removing equipment covers, opening access panels, and other required activities that assist with visual oversight. Furnish ladders, flashlights, meters, gauges, or other inspection equipment as necessary.

1.4 COORDINATION

Refer to Section 01 91 00.15 BUILDING COMMISSIONING for requirements pertaining to coordination during the commissioning process. Coordinate with the Lead Commissioning Specialist in accordance with Section 01 91 00.15 and in accordance with the Commissioning Plan to schedule inspections as required to support the commissioning process. Furnish additional information requested by the Lead Commissioning Specialist. Coordinate scheduling of Functional Performance Testing with the commissioning team. Provide plans, reports, notes, and other documentation to the Lead Commissioning Specialist as specified in the commissioning plan, as it is completed.

1.5 PIPE FLUSHING, TESTING, AND WATER TREATMENT REPORTS

Test requirements are specified in Division 22 and 23 piping Sections. Prepare a pipe system cleaning, flushing, and hydrostatic testing log. Provide cleaning, flushing, testing, and water treatment log and final reports.

Include the following in the pipe system cleaning, flushing, and hydrostatic testing log:

a. Minimum flushing water velocity.

b. Water treatment reports.

c. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

1.6 CERTIFICATE OF READINESS

Submit Certificate of Readiness documentation in accordance with Section 01 91 00.15 BUILDING COMMISSIONING for all equipment and systems including start-up reports; completed Pre-Functional Checklists; Testing, Adjusting, and Balancing (TAB) Report; Issues Log; HVAC Controls Start-Up Reports; Performance Verification Test Reports; and the building envelope Air Leakage Test Reports and Diagnostic Test Reports. Do not schedule Functional Performance Tests for the system until the Certificate of Readiness for that system receives approval by the Government. The CxC, Quality Control Manager, and the Mechanical, Electrical, Controls, and TAB subcontractor representatives must sign and date the Certificate of Readiness.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

Provide all testing equipment required to perform testing for the systems to be commissioned, except for equipment specific to and used by TAB as required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Provide a sufficient quantity of two-way radios for each subcontractor. Submit list of Test Equipment and instrumentation to be used for testing including equipment/instrument identification number, equipment application or planned use, manufacturer, make, model, and serial number, and calibration history with certificates. Also list special equipment and proprietary tools specific to a piece of equipment required for testing.

2.1.1 Proprietary Equipment

Provide manufacturer's proprietary test equipment and software required by any equipment manufacturer for programming and start-up, whether specified or not. Provide manufacturer test equipment, demonstrate its use, and assist in the commissioning process as needed. Provide data logging equipment and software required to test equipment.

2.1.2 Calibration and Accuracy

Comply with equipment manufacturer's test equipment calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to Contracting Officer upon request.

Provide all testing equipment of sufficient quality and accuracy to test and measure system performance with the tolerances specified. Unless otherwise noted, the following minimum requirements apply: Provide temperature sensors and digital thermometers with a certified calibration within the past year to an accuracy of 0.5 degrees F and a resolution of plus or minus 0.1 degrees F. Provide pressure sensors with an accuracy of plus or minus 2.0 percent of the value range being measured (not full range of meter) and calibrated within the last year.

PART 3 EXECUTION

3.1 MEETINGS

Attend all meetings in accordance with Section 01 91 00.15 BUILDING

COMMISSIONING.

Provide timely updates on construction schedule changes to allow the Lead Commissioning Specialist to execute commissioning process efficiently. Notify Contracting Officer of anticipated construction delays to commissioning activities not yet performed or not yet scheduled.

3.2 COMMISSIONING CONSTRUCTION OBSERVATION CHECKLISTS

Commissioning construction observation checklists include Pre-Functional Checklists, Integrated Systems Test Checklists, and Functional Performance Test Checklists. Provide commissioning construction observation checklists for the Interim and Final Construction Phase Commissioning Plan in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

Download example Pre-Functional Checklists, Integrated Systems Test Checklists, and Functional Performance Test Checklists for Section 01 91 00.15 BUILDING COMMISSIONING at the following location: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphics-tables. The checklists submitted in the Interim and Final Construction Phase Commissioning Plans must contain the same level of detail shown in the examples. The submitted checklists are not required to match the format of the examples.

3.2.1 Pre-Functional Checklists

The Pre-Functional Checklists must include items for physical inspection or testing that demonstrate that installation and start-up of equipment and systems is complete. Refer to paragraph PRE-FUNCTIONAL CHECKS. Pre-functional checklists must be tailored to verify the specific installation requirements and details of the construction documents and manufacturer's instructions.

3.2.2 Functional Performance Test Checklists

Functional Performance Test Checklists must include procedures that explain, step-by-step, the actions and expected results that will demonstrate that the system performs in accordance with the contract. Refer to paragraph FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTING. Include the following sections and details appropriate to the systems being tested in the Functional Performance Test Checklists:

a. Notable system features including information about controls to facilitate understanding of system operation and maintenance

b. Conclusions and recommendations. Conclusions must clearly indicate if system does or does not perform in accordance with contract requirements and specifications. Recommendation must clearly indicate that the system should or should not be approved by the Government.

c. Test conditions including date, beginning and ending time, and beginning and ending outdoor air conditions

d. Attendees

e. Identification of the equipment involved in the test

f. **System feature identification**

g. Point-to-point observations including demonstrating system flow meters and sensors have been calibrated and are correctly displayed on the Operator work station

h. Actuator operation observations demonstrating actuator responses to commands from the control system

i. As-found condition of the system operation

j. List of test items with step numbers along with the corresponding feature or control operation, intended test procedure, expected system response, and pass/fail indication.

k. Space for comments for each test item.

3.2.3 Integrated Systems Test Checklists

Integrated Systems Test Checklists must include test procedures that explain, step-by-step, the actions and expected results that will demonstrate that the interactive operations between systems performs in accordance with the contract. Refer to paragraph FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTING. Include the following sections in the Integrated Systems Test Checklists:

a. Notable features of the interconnected systems organized by discipline including information to facilitate understanding of system operation

b. Conclusions and recommendations. Conclusions must clearly indicate if the systems do or do not perform in accordance with contract requirements and specifications. Recommendation must clearly indicate that the systems should or should not be approved by the Government

c. Test conditions including date and beginning and ending time

d. Identification of the equipment and systems involved in the test

e. List of test items with step numbers along with the corresponding feature or control operation, intended test procedure, expected system response, and pass/fail indication.

f. Space for comments for each test item.

3.3 PRE-FUNCTIONAL CHECKS

Pre-Functional Checks are a type of Commissioning Inspection in accordance with Section 01 91 00.15 BUILDING COMMISSIONING. Complete one Pre-Functional Checklist for each individual item of equipment or system for each system required to be commissioned including, but not limited to, ductwork, piping, equipment, fixtures, and controls. Include manufacturer start-up checklists associated with equipment with the submission of the Pre-Functional Checklists. Provide manufacturer's installation manual for each type of unit. Indicate commissioning team member inspection and validation of each Pre-Functional Checklist item by initials. Validation of each Pre-Functional Checklist item by each team member indicates that item conforms to the contract documents and validated design in their area of responsibility. Validation of each item by each team member must occur immediately following completion of their respective duties related to the item. Commissioning Specialist validation of each Pre-Functional Checklist item indicates that each item has been installed correctly and

in accordance with contract documents. Required commissioning team members for Pre-Functional Checks includes the CxC, Mechanical Commissioning Specialist, Quality Control Manager, sub-contractor representative for each trade responsible for construction/installation of the checklist item, and the TAB representative (for items impacting TAB). Submit the initialed and Completed Pre-Functional Checklists no later than 7 calendar days after completion of inspection of all checklists items for each system.

3.4 STARTUP AND INITIAL CHECKOUT

Document start-up and initial testing procedures, and include in the Completed Pre-Functional Checklists submittal, including:

a. Startup tests and factory testing reports.

b. Manufacturer's representative start-up, operating, troubleshooting and maintenance procedures.

c. Perform and clearly document system operational checks and quality control checks as they are completed, and providing a copy to the commissioning team.

d. Correct deficiencies and sign the Certificate of Readiness for each system before functional performance testing

3.5 TESTING, ADJUSTING, AND BALANCING REPORT REVIEW AND VERIFICATION

3.5.1 Testing, Adjusting, and Balancing (TAB) Report Review

The Mechanical System Technical Commissioning Specialist must review the pre-final TAB Report required by Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. All deficiencies must be resolved prior to TAB Report approval.

3.6 HVAC CONTROLS START-UP AND PERFORMANCE VERIFICATION TEST REVIEW

The Mechanical System Technical Commissioning Specialist must review the Start-Up Testing Report, PVT Procedures and PVT Reports, including endurance testing trend submittals, required by Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION. The Mechanical System Technical Commissioning Specialist must review each submittal and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel and include in the issues log. All deficiencies must be resolved prior to final acceptance.

3.7 FUNCTIONAL PERFORMANCE AND INTEGRATED SYSTEMS TESTING

Functional Performance and Integrated Systems Testing are a type of Commissioning Testing in accordance with Section 01 91 00.15 BUILDING COMMISSIONING. Conduct Functional Performance Testing in accordance with Section 01 91 00.15 BUILDING COMMISSIONING and requirements in this Section. Prior to Functional Performance Testing, complete all prerequisites in accordance with paragraph SEQUENCING AND SCHEDULING. Demonstrate that all system components have been installed, that each

control device and item of equipment operates, and that the systems operate and perform, including interactive operation between systems, in accordance with contract documents.

Perform Integrated Systems Tests only after the Functional Performance Tests for each associated system are completed with all deficiencies resolved and after the related Functional Performance Test Checklists have been signed by each commissioning team member.

3.7.1 Test Scheduling and Coordination

Schedule and conduct Initial Functional Performance Tests. Develop and implement means of artificial loading to demonstrate, to a reasonable level of confidence, the ability of the HVAC systems to handle peak seasonal loads. Schedule Functional Performance Tests for each system only after the Certificate of Readiness has been approved by the Government for the system. Correct all deficiencies identified through any prior review, inspection, or test activity before the start of Functional Performance Tests.

Functional Performance Tests and Integrated Systems Tests must be performed with the CxC present. Government reserves the right to witness all tests. Coordinate test schedule with Government representatives.

3.7.2 Preparation

Put equipment and systems into operation and continue operation during each working day of functional performance and integrated systems testing, as required. Verify temperature and pressure taps in accordance with Contract Documents. Provide a pressure/temperature plug at each water sensor which is an input point to control system.

Perform minor adjustments to equipment and systems during Functional Performance Tests as deemed necessary by the commissioning team. Where calibrated DDC sensors cannot be used to record test data, provide measuring instruments, logging devices, and data acquisition equipment to record data for the complete range of test data for the required test period.

3.7.3 Testing Procedures

Provide all necessary materials and system modifications to produce the necessary flows, pressures, temperatures, and other conditions necessary to execute the test according to the specified conditions. At completion of the test, return the affected building equipment and systems to their pre-test condition.

Follow the Functional Performance Test from the approved Final Construction Phase Commissioning Plan. Perform Functional Performance Tests for each item of equipment and each system required to be commissioned. Verify all sensor calibrations, control responses, safeties, interlocks, operating modes, sequences of operation, capacities, and all other performance requirements comply with contract, regardless of the specific items listed within the checklists provided. In general, testing must progress from equipment or components to subsystems to systems to interlocks and connections between systems. Commissioning Specialists are responsible for determining the order of components and systems to be tested.

Indicate validation of each item of equipment and systems tested by signature of each commissioning team member for each test. The Quality Control Representative, Commissioning Specialists, and Contracting Officer's Representative, if present, must indicate validation after the equipment and systems are free of deficiencies.

3.7.4 Simulating Conditions

Functional performance testing is conducted by simulating conditions at control devices to initiate a control system response. Before testing, calibrate all sensors, transducers and devices. Over-writing control input values through the control system is not acceptable unless approved by the Contracting Officer. Perform each test under conditions that simulate actual conditions as close as is practically possible. Specific examples of simulating conditions are provided below. Do not simulate conditions when damage to the system or building may result.

a. When varying static pressures inside ductwork cannot be simulated within the duct, and where a sensor signals the controls system to initiate sequences at various duct static pressures, it is acceptable to simulate the various pressures with a Pneumatic Squeeze-Bulb Type Signaling Device with gauge temporarily attached to the sensing tube leading to the transmitter. It is not acceptable to reset the various set-points, nor to simulate an electric analog signal (unless approved as noted above).

b. Dirty filter pressure drops can be simulated by partially blocking filter face.

c. Freeze-stat safeties can be simulated by packing portion of sensor with ice.

d. High outside air temperatures can be simulated with a hair blower.

e. Raising entering cooling coil temperatures by activating a heating/preheat coil can be used to simulate entering cooling coil conditions.

f. Do not use signal generators to simulate sensor signals unless approved by the Contracting Officer, as noted above, for special cases.

g. Control set points can be altered. For example, to see the air conditioning compressor lockout work at an outside air temperature below 55 degrees F, when the outside air temperature is above 55 degrees F, temporarily change the lockout set point to be 0 degrees F above the current outside air temperature. Caution: Set points are not to be raised or lowered to a point to cause damage to the components, systems, or the building structure and contents.

h. Test duct mounted smoke detectors in accordance with the manufacturer's recommendations. Perform the tests with air system at minimum airflow condition.

i. Test current sensing relays used for fan and pump status signals to control system to indicate unit failure and run status by resetting the set point on the relay to simulate a lost belt or unit failure while the unit is running. Confirm that the failure alarm was generated and received at the control system. After the test is conducted, return the set point to its original set-point or a

set-point as indicated by the Contracting Officer.

3.7.5 Manufacturer's Representative

Provide a factory trained representative authorized by the equipment manufacturer to perform Functional Performance Testing for the following equipment:

See Section 26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES for Manufacturer's Representative requirements.Ensure the test representative reviews, approves, and signs the completed field test report. Include person's name with signatures.

3.7.6 Integrated Systems Tests

Follow the Integrated Systems Test Checklists from the approved Final Construction Phase Commissioning Plan. Integrated Systems Tests must be performed for the interactive operation between HVAC systems and other systems such as fire protection systems, smoke control systems, or back-up electrical supply. Verify correct interactive operation, acceptable speed of response, and other contract requirements for both normal and failure modes. Examples of Integrated Systems Tests include the correct operation of HVAC systems during emergency system activation or correct operation of uninterruptible power supplies or energy generators and connected systems.

3.7.7 Sample Strategy

Perform Functional Performance Tests using the following sample strategy. Complete a Functional Performance Test Checklist for each item of equipment or system to be tested. During testing, Government representatives may select the specific equipment or system to be tested for sample sizes less than 100 percent. Equipment Identifiers are as indicated on the design drawings:

Equipment Identifier	Sample Size (Percent)
Split-system Heat Pumps	100
Electric Unit Heaters	100
Supply Fans	100
Domestic Water Heaters	100

Perform Integrated Systems Tests and complete an Integrated Systems Test Checklist for for all (100 percent) systems and equipment having interactive operation.

3.7.7.1 100 Percent Sample Procedures

Systems or equipment for which 100 percent sample size are tested fail if one or more of the test procedures results in discovery of a deficiency and the deficiency cannot be resolved within 5 minutes during the test.

Re-test to the extent necessary to confirm that the deficiencies have been corrected without negatively impacting the performance of the rest of the system.

3.8 INTEGRATED SYSTEMS TEST

Perform Integrated Systems Tests only after the Functional Performance Tests for each associated system are completed with all deficiencies resolved and after the related Functional Performance Test Checklists have been signed by each commissioning team member.

3.9 RETESTING REQUIREMENTS

Abort tests if any deficiency prevents successful completion of the test or if any required commissioning team member is not present for the test. Re-test only after all deficiencies identified during the original tests have been corrected.

Contracting Officer may withhold payment equivalent to lost time, re-testing, and aborted tests. These costs may include salary, travel costs, and per diem for Government team members. Correct deficiencies as identified by the commissioning team and retest the systems to be commissioned.

3.10 SYSTEM ACCEPTANCE

Systems may be partially accepted prior to seasonal testing if they comply with all construction contract and accepted design requirements that can be tested during initial Functional Performance Tests. All test procedures must be successful completed prior to full systems acceptance.

3.11 TRAINING

The Mechanical Systems Technical Commissioning Specialist must review the training plan required by Section 01 78 23 OPERATION AND MAINTENANCE DATA and identify any deficiencies to the Contracting Officer's Representative and the Contractor's Quality Control Personnel.

3.12 COMMISSIONING REPORT

Include all completed Pre-Functional Checklists and Functional Performance and Integrated Systems Test Checklists in the Commissioning Report as specified in Section 01 91 00.15 BUILDING COMMISSIONING. Include the approved TAB Report.

3.13 POST-CONSTRUCTION ENDURANCE TEST

Perform an Endurance Test in accordance with the paragraph ENDURANCE TEST in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC once during the peak heating season and once during the peak cooling season during outdoor air condition extremes with the exception that network bandwidth usage measurement and recording is not required. Use the Temporary Trending Hardware, if necessary, in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

The Mechanical System Commissioning Specialists must review the trend logs from the Endurance Tests to ensure that the systems have stable operation and operate as required by the construction contract. The Commissioning Specialists must provide a Post-Construction Trend Log Report that identifies any deficiencies noted in operation, recommendations for correction, and includes a graphical representation of the trends. Provide one Trend Log Report for the peak cooling season and one Trend Log Report for the peak heating season. Submit the Post-Construction Trend

Log Reports no later than 14 calendar days following receipt of the trend log data by the Commissioning Specialist. Include the Post-Construction Trend Log Reports in the Updated Final Commissioning Report as specified in Section 01 91 00.15 BUILDING COMMISSIONING

-- End of Section --

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QC Checklist for Niagara Framework Based BACnet Systems

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS

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SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC
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PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the Front End which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as indicated and shown and in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, Section 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC, and other referenced Sections.

1.1.1 Proprietary Systems

1.1.1.1 Proprietary Systems Exempted From Open Protocol Requirements

The following systems are specifically exempted from the open protocol requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS:

a. A simple split (DX) system consisting of a single indoor unit and a single outdoor unit from the same manufacturer.

1.1.1.2 Implementation of Proprietary Systems

For proprietary systems exempted from open protocol requirements, a proprietary network and DDC hardware communicating via a proprietary protocol are permitted. For these systems a building control network meeting the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS must also be provided, along with a gateway or interface to connect the proprietary system to the open building control network.

The proprietary system gateway or interface must provide the required functionality as shown on the points schedule. Scheduling, alarming, trending, overrides, network inputs, network outputs and other protocol related requirements must be met on the open protocol control system as specified in Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

1.1.2 System Requirements

Provide systems meeting the requirements this Section and other Sections referenced by this Section, and which have the following characteristics:

The system implements the control sequences of operation shown in the Contract Drawings using DDC hardware to control mechanical and electrical equipment

The system meet the requirements of this specification as a stand-alone

system and does not require connection to any other system.

Control sequences reside in DDC hardware in the building. The building control network is not dependent upon connection to a Utility Monitoring and Control System (UMCS) Front End or to any other system for performance of control sequences. To the greatest extent practical, the hardware performs control sequences without reliance on the building network, unless otherwise pre-approved by the Contracting Officer.

The hardware is installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

All necessary documentation, configuration information, programming tools, programs, drivers, and other software are licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

Sufficient documentation and data, including rights to documentation and data, are provided such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

Hardware is installed and configured such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor, Vendor or Manufacturer.

All Niagara Framework components have an unrestricted interoperability license with a Niagara Compatibility Statement (NiCS) following the Tridium Open NiCS Specification and have a value of "ALL" for "Station Compatibility In", "Station Compatibility Out", "Tool Compatibility In" and "Tool Compatibility Out". Note that this will result in the following entries in the license file:

```
accept.station.in="*"
accept.station.out="*"
accept.wb.in="*"
accept.wb.out="*"
```

1.1.3 End to End Accuracy

Select products, install and configure the system such that the maximum error of a measured value as read from the DDC Hardware over the network is less than the maximum allowable error specified for the sensor or instrumentation.

1.1.4 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.5 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the

mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere:

Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet systems with or without Niagara Framework.

Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

Section 25 08 10 UTILITY MONITORING AND CONTROL SYSTEMS TESTING

Section 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC

Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEMS (UMCS) FRONT END AND INTEGRATION

Section 23 81 00 DECENTRALIZED UNITARY HVAC EQUIPMENT

Section 01 91 00.15 BUILDING COMMISSIONING

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks
ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National

	Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

TRIDIUM, INC (TRIDIUM)

Niagara Framework	(2021) NiagaraAX User's Guide
Tridium Open NiCS	(2021) Understanding the NiagaraAX Compatibility Statement (NiCS)

UL SOLUTIONS (UL)

UL 5085-3	(2006; Reprint Jan 2022) UL Standard for Safety Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 DEFINITIONS

The following list of definitions includes terms used in Sections referenced by this Section and are included here for completeness. The definitions contained in this Section may disagree with how terms are defined or used in other documents, including documents referenced by this Section. The definitions included here are the authoritative definitions for this Section and all Sections referenced by this Section.

After each term the protocol related to that term is included in parenthesis.

1.4.1 Alarm Generation (All protocols)

Alarm Generation is the monitoring of a value, comparison of the value to alarm conditions and the creation of an alarm when the conditions set for the alarm are met. Note that this does NOT include delivery of the alarm to the final destination (such as a user interface) - see paragraph ALARM ROUTING in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

1.4.2 Building Automation and Control Network (BACnet) (BACnet)

The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. The second to refer to the overall technology related to the ASHRAE 135 protocol.

1.4.3 BACnet Advanced Application Controller (B-AAC) (BACnet)

A hardware device BTL Listed as a B-AAC, which is required to support BACnet Interoperability Building Blocks (BIBBs) for scheduling and alarming, but is not required to support as many BIBBs as a B-BC.

1.4.4 BACnet Application Specific Controller (B-ASC) (BACnet)

A hardware device BTL Listed as a B-ASC, with fewer BIBB requirements than a B-AAC. It is intended for use in a specific application.

1.4.5 BACnet Building Controller (B-BC) (BACnet)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

1.4.6 BACnet Broadcast Management Device (BBMD) (BACnet)

A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Each IP subnet that is part of a BACnet/IP network must have at least one BBMD. Note there are additional restrictions when multiple BBMDs share an IP subnet.

1.4.7 BACnet/IP (BACnet)

An extension of BACnet, Annex J, defines the use of a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnets that share the same BACnet network number. See also paragraph BACNET BROADCAST MANAGEMENT DEVICE.

1.4.8 BACnet Internetwork (BACnet)

Two or more BACnet networks, connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

1.4.9 BACnet Interoperability Building Blocks (BIBBs) (BACnet)

A BIBB is a collection of one or more ASHRAE 135 Services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by a front-end, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

In the BIBB shorthand notation, -A is the client side and -B is the server side.

The following is a list of some BIBBs used by this or referenced Sections:	
DS-COV-A	Data Sharing-Change of Value (A side)
DS-COV-B	Data Sharing-Change of Value (B side)

The following is a list of some BIBBs used by this or referenced Sections:	
NM-RC-B	Network Management-Router Configuration (B side)
DS-RP-A	Data Sharing-Read Property (A side)
DS-RP-B	Data Sharing-Read Property (B side)
DS-RPM-A	Data Sharing-Read Property Multiple (A Side)
DS-RPM-B	Data Sharing-Read Property Multiple (B Side)
DS-WP-A	Data Sharing-Write Property (A Side)
DM-TS-B	Device Management-Time Synchronization (B Side)
DM-UTC-B	Device Management-UTC Time Synchronization (B Side)
DS-WP-B	Data Sharing-Write Property (B side)
SCHED-E-B	Scheduling-External (B side)
DM-OCD-B	Device Management-Object Creation and Deletion (B side)
AE-N-I-B	Alarm and Event-Notification Internal (B Side)
AE-N-E-B	Alarm and Event-Notification External (B Side)
T-VMT-I-B	Trending-Viewing and Modifying Trends Internal (B Side)
T-VMT-E-B	Trending-Viewing and Modifying Trends External (B Side)

1.4.10 BACnet Network (BACnet)

In BACnet, a portion of the control Internetwork consisting of one or more segments connected by repeaters. Networks are separated by routers.

1.4.11 BACnet Operator Display (B-OD) (BACnet)

A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. A B-OD profile could be used for LCD devices, displays affixed to BACnet devices, handheld terminals or other very simple user interfaces.

1.4.12 BACnet Segment (BACnet)

One or more physical segments interconnected by repeaters (ASHRAE 135).

1.4.13 BACnet Smart Actuator (B-SA) (BACnet)

A simple actuator device with limited resources intended for specific applications.

1.4.14 BACnet Smart Sensor (B-SS) (BACnet)

A simple sensing device with limited resources.

1.4.15 BACnet Testing Laboratories (BTL) (BACnet)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

1.4.16 BACnet Testing Laboratories (BTL) Listed (BACnet)

A device that has been listed by BACnet Testing Laboratory. Devices may be certified to a specific device profile, in which case the listing indicates that the device supports the required capabilities for that profile, or may be listed as "other".

1.4.17 Binary (All protocols)

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.4.18 Broadcast (BACnet)

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

1.4.19 Building Control Network (BCN) (All protocols)

The network connecting all DDC Hardware within a building (or specific group of buildings).

1.4.20 Building Point of Connection (BPOC) (All protocols)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware.)

1.4.21 Commandable (All protocols)

See Overridable.

1.4.22 Commandable Objects (BACnet)

Commandable Objects have a Commandable Property, Priority_Array, and Relinquish_Default Property as defined in ASHRAE 135, Clause 19.2, Command Prioritization.

1.4.23 Configurable (All protocols)

A property, setting, or value is configurable if it can be changed via hardware settings on the device, via the use of engineering software or over the control network from the front end, and is retained through (after) loss of power.

a. In a Niagara Framework BACnet system, a property, setting, or value is

configurable if it can be changed via one or more of:
(1) via BACnet services (including proprietary BACnet services)
(2) via hardware settings on the device
(3) via the Niagara Framework

Note this is more stringent than the ASHRAE 135 definition.

1.4.24 Control Logic Diagram (All protocols)

A graphical representation of control logic for multiple processes that make up a system.

1.4.25 Device (BACnet)

A Digital Controller that contains a BACnet Device Object and uses BACnet to communicate with other devices.

1.4.26 Device Object (BACnet)

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet Internetwork. This number is often referred to as the device instance or device ID.

1.4.27 Device Profile (BACnet)

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE 135. Standard device profiles include BACnet Advanced Workstations (B-AWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS).

1.4.28 Digital Controller (All protocols)

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions.

1.4.29 Direct Digital Control (DDC) (All protocols)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

1.4.30 Field Point of Connection (FPOC) (All protocols)

The FPOC is the point of connection between the UMCS IP Network and the field control network (either an IP network, a non-IP network, or a combination of both). The hardware at this location which provides the connection is generally an IT device such as a switch, IP router, or firewall.

In general, the term "FPOC Location" means the place where this connection occurs, and "FPOC Hardware" means the device that provides the connection. Sometimes the term "FPOC" is used to mean either and its actual meaning (i.e. location or hardware) is determined by the context in which it is used.

1.4.31 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911.

1.4.32 Gateway (All protocols)

A device that translates from one protocol application data format to another. Devices that change only the transport mechanism of the protocol - "translating" from TP/FT-10 to Ethernet/IP or from BACnet MS/TP to BACnet over IP for example - are not gateways as the underlying data format does not change. Gateways are also called Communications Bridges or Protocol Translators.

A Niagara Framework Supervisory Gateway is one type of Gateway.

1.4.33 IEEE 802.3 Ethernet (All protocols)

A family of local-area-network technologies providing high-speed networking features over various media, typically Cat 5, 5e or Cat 6 twisted pair copper or fiber optic cable.

1.4.34 Internet Protocol (IP, TCP/IP, UDP/IP) (All protocols)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes connections, also known as "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

1.4.35 Input/Output (I/O) (All protocols)

Physical inputs and outputs to and from a device, although the term sometimes describes network or "virtual" inputs or outputs. See also "Points".

1.4.36 I/O Expansion Unit (All protocols)

An I/O expansion unit provides additional point capacity to a digital controller

1.4.37 IP subnet (All protocols)

A group of devices which share a defined range IP addresses. Devices on a common IP subnet can share data (including broadcasts) directly without the need for the traffic to traverse an IP router.

1.4.38 JACE (Niagara Framework)

Java Application Control Engine. See paragraph NIAGARA FRAMEWORK SUPERVISORY GATEWAY

1.4.39 Local-Area Network (LAN) (All protocols)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

1.4.40 Local Display Panels (LDPs) (All protocols)

A DDC Hardware with a display and navigation buttons, and must provide display and adjustment of points as shown on the Points Schedule and as indicated.

1.4.41 MAC Address (All protocols)

Media Access Control address. The physical device address that identifies a device on a Local Area Network.

1.4.42 Master-Slave/Token-Passing (MS/TP) (BACnet)

Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.

1.4.43 Monitoring and Control (M&C) Software (All protocols)

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.4.44 Network Number (BACnet)

A site-specific number assigned to each network. This network number must be unique throughout the BACnet Internetwork.

1.4.45 Niagara Framework (Niagara Framework)

A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

1.4.46 Niagara Framework Supervisory Gateway (Niagara Framework)

DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-based user interface.

Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include (but are not limited to)"EC-BOS", "FX-40", "TMN", "SLX" and "UNC".

1.4.47 Object (BACnet)

An ASHRAE 135 Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

1.4.48 Object Identifier (BACnet)

A grouping of two Object properties: Object Type (e.g. Analog Value, Schedule, etc.) and Object Instance (in this case, a number). Object Identifiers must be unique within a device.

1.4.49 Object Instance (BACnet)

See paragraph OBJECT IDENTIFIER

1.4.50 Object Properties (BACnet)

Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

1.4.51 Operator Configurable (All protocols)

Operator configurable values are values that can be changed from a single common front end user interface across multiple vendor systems.

For Niagara Framework Systems, a property, setting, or value is Operator Configurable when it is configurable from a Niagara Framework Front End.

1.4.52 Override (All protocols)

Changing the value of a point outside of the normal sequence of operation where the change has priority over the sequence and where there is a mechanism for releasing the change such that the point returns to the normal value. Overrides persist until released or overridden at the same or higher priority but are not required to persist through a loss of power. Overrides are often used by operators to change values, and generally originate at a user interface (workstation or local display panel).

1.4.53 Packaged Equipment (All protocols)

Packaged equipment is a single piece of equipment provided by a manufacturer in a substantially complete and operable condition, where the controls (DDC Hardware) are factory installed, and the equipment is sold and shipped from the manufacturer as a single entity. Disassembly and reassembly of a large piece of equipment for shipping does not prevent it from being packaged equipment. Package units may require field installation of remote sensors. Packaged equipment is also called a "packaged unit".

Note industry may use the term "Packaged System" to mean a collection of equipment that is designed to work together where each piece of equipment is packaged equipment and there is a network that connects the equipment together. A "packaged system" of this type is NOT packaged equipment; it is a collection of packaged equipment, and each piece of equipment must individually meet specification requirements.

1.4.54 Packaged Unit (All protocols)

See packaged equipment.

1.4.55 Performance Verification Test (PVT) (All protocols)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

1.4.56 Physical Segment (BACnet)

A single contiguous medium to which BACnet devices are attached (ASHRAE 135).

1.4.57 Polling (All protocols)

A device periodically requesting data from another device.

1.4.58 Points (All protocols)

Physical and virtual inputs and outputs. See also paragraph INPUT/OUTPUT (I/O).

1.4.59 Proportional, Integral, and Derivative (PID) Control Loop (All protocols)

Three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC systems (leaving "PI" control).

1.4.60 Proprietary (BACnet)

Within the context of BACnet, any extension of or addition to object types, properties, PrivateTransfer services, or enumerations specified in ASHRAE 135. Objects with Object_Type values of 128 and above are Proprietary Objects. Properties with Property_Identifier of 512 and above are proprietary Properties.

1.4.61 Protocol Implementation Conformance Statement (PICS) (BACnet)

A document, created by the manufacturer of a device, which describes which portions of the BACnet standard may be implemented by a given device. ASHRAE 135 requires that all ASHRAE 135 devices have a PICS, and also defines a minimum set of information that must be in it. A device as installed for a specific project may not implement everything in its PICS.

1.4.62 Repeater (All protocols)

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.4.63 Router (All protocols)

A device that connects two ASHRAE 135 networks and controls traffic between the two by retransmitting signals received from one side onto the other based on the signal destination. Routers are used to subdivide a BACnet internetwork and to limit network traffic.

1.4.64 Segment (All protocols)

A 'single' section of a control network that contains no repeaters or

routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type.

1.4.65 Standard BACnet Objects (BACnet)

Objects with Object_Type values below 128 and specifically enumerated in Clause 21 of ASHRAE 135. Objects which are not proprietary. See paragraph PROPRIETARY.

1.4.66 Standard BACnet Properties (BACnet)

Properties with Property_Identifier values below 512 and specifically enumerated in Clause 21 of ASHRAE 135. Properties which are not proprietary. See Proprietary.

1.4.67 Standard BACnet Services (BACnet)

ASHRAE 135 services other than ConfirmedPrivateTransfer or UnconfirmedPrivateTransfer. See paragraph PROPRIETARY.

1.4.68 UMCS (All protocols)

UMCS stands for Utility Monitoring and Control System. The term refers to all components by which a project site monitors, manages, and controls real-time operation of HVAC and other building systems. These components include the UMCS "front-end" and all field building control systems connected to the front-end. The front-end consists of Monitoring and Control Software (user interface software), browser-based user interfaces and network infrastructure.

The network infrastructure (the "UMCS Network"), is an IP network connecting multiple building or facility control networks to the Monitoring and Control Software.

1.4.69 UMCS Network (All protocols)

The UMCS Network connects multiple building or facility control networks to the Monitoring and Control Software.

1.4.70 Writable Property (BACnet)

A Property is Writable when it can be changed through the use of one or more of the WriteProperty services defined in ASHRAE 135, Clause 15 regardless of the value of any other Property. Note that in the ASHRAE 135 standard, some Properties may be writable when the Out of Service Property is TRUE; for purposes of this Section, Properties that are only writable when the Out of Service Property is TRUE are not considered to be Writable.

1.5 PROJECT SEQUENCING

TABLE II: PROJECT SEQUENCING lists the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column). TABLE II does not specify overall project milestone and completion dates; these dates are specified in the contract documents.

a. Sequencing for Submittals: The sequencing specified for submittals is

the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon resubmittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

b. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin. Final dates will be coordinated with the COR.

c. Abbreviations: In TABLE II the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE II. PROJECT SEQUENCING

ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
1	S	Existing Conditions Report	
2	S	DDC Contractor Design Drawings	
3	S	Manufacturer's Product Data	
4	S	Pre-construction QC Checklist	
5	E	Install Building Control System	AAO #1 thru #4
6	E	Start-Up and Start-Up Testing	ACO #5
7	S	Post-Construction QC Checklist	days ACO #6
8	S	Programming Software Configuration Software Niagara Framework Engineering Tool Niagara Framework Wizards	days ACO #6
9	S	Draft As-Built Drawings	days ACO #6
10	S	Start-Up Testing Report	days ACO #6
11	S	PVT Procedures	days before schedule start of #12 and AAO #10

TABLE II. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
12	E	Execute PVT	AAO #9 and #11
13	S	PVT Report	days ACO #12
14	S	Controller Application Programs Controller Configuration Settings Niagara Framework Supervisory Gateway Backups	days AAO #13
15	S	Final As-Built Drawings	days AAO #13
16	S	O&M Instructions	AAO #15
17	S	Training Documentation	AAO #10 and days before scheduled start of #18
18	E	Training	AAO #16 and #17
19	S	Closeout QC Checklist	ACO #18

1.6 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

DDC Contractor Design Drawings; G, DO

Draft As-Built Drawings; G, RO

Final As-Built Drawings; G, RO

SD-03 Product Data

Programming Software; G, RO

Controller Application Programs; G, RO

Configuration Software; G, RO

Controller Configuration Settings; G, RO

Manufacturer's Product Data; G, RO

Niagara Framework Supervisory Gateway Backups; G, RO

Niagara Framework Engineering Tool; G, RO

Niagara Framework Wizards; G, RO

SD-06 Test Reports

Pre-Construction Quality Control (QC) Checklist; G, RO

Post-Construction Quality Control (QC) Checklist; G, RO

Start-Up Testing Report; G, RO

PVT Procedures; G, RO

PVT Report; G, RO

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, RO

Training Documentation; G, RO

SD-11 Closeout Submittals

Enclosure Keys; G, RO

Password Summary Report; G, RO

Closeout Quality Control (QC) Checklist; G, RO

1.6.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.7 DATA PACKAGE AND SUBMITTAL REQUIREMENTS

Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software) which are

specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted rights.

1.8 SOFTWARE FOR DDC HARDWARE AND GATEWAYS

Provide all software related to the programming and configuration of DDC Hardware and Gateways as indicated. License all Software to the project site. The term "controller" as used in these requirements means both DDC Hardware and Gateways.

1.8.1 Configuration Software

For each type of controller, provide the configuration tool software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of the software user manuals for each software with the software submittal.

Submit Configuration Software on CD-ROM as a Technical Data Package. Submit 2 hard copies of the software user manual for each piece of software.

1.8.2 Controller Configuration Settings

For each controller, provide copies of the installed configuration settings as source code compatible with the configuration tool software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Configuration Settings on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit 2 copies of the Controller Configuration Settings CD-ROM.

1.8.3 Programming Software

For each type of programmable controller, provide the programming software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of software user manuals for each software with the software submittal.

Submit Programming Software on CD-ROM as a Technical Data Package. Submit 2 hard copies of the software user manual for each piece of software.

1.8.4 Controller Application Programs

For each programmable controller, provide copies of the application program as source code compatible with the programming software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Controller Application Programs on CD-ROM as a Technical Data

Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit 2 copies of the Controller Application Programs CD-ROM.

1.8.5 Niagara Framework Supervisory Gateway Backups

For each Niagara Framework Supervisory Gateway, provide a backup of all software within the Niagara Framework Supervisory Gateway, including configuration settings. This backup must be sufficient to allow the restoration of the Niagara Framework Supervisory Gateway or the replacement of the Niagara Framework Supervisory Gateway.

Submit backups for each Niagara Framework Supervisory Gateway on CD-ROM as a Technical Data Package. Mark each backup indicating clearly the source Niagara Framework Supervisory Gateway.

1.8.6 Niagara Framework Engineering Tool(for all Niagara Framework system)

Provide a Niagara Framework Engineering Tool in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit software user manuals with the Niagara Framework Engineering Tool submittal.

Submit the Niagara Framework Engineering Tool on CD-ROM as a Technical Data Package. Submit 2 hard copies of the software user manual for the Niagara Framework Engineering Tool.

1.9 QUALITY CONTROL CHECKLISTS

The QC Checklist for Niagara Framework Based BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated.

The QC Representative must verify each item indicated and initial in the space provided to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

1.9.1 Pre-Construction Quality Control (QC) Checklist

Complete items indicated as Pre-Construction QC Checklist items in the QC Checklist. Submit two copies of the Pre-Construction QC Checklist.

1.9.2 Post-Construction Quality Control (QC) Checklist

Complete items indicated as Post-Construction QC Checklist items in the QC Checklist. Submit two copies of the Post-Construction QC Checklist.

1.9.3 Closeout Quality Control (QC) Checklist

Complete items indicated as Closeout QC Checklist items in the QC Checklist. Submit two copies of the Closeout QC Checklist.

PART 2 PRODUCTS

Provide products meeting the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for

BACnet or Niagara BACnet systems, other referenced Sections, and this Section.

2.1 GENERAL PRODUCT REQUIREMENTS

Units of the same type of equipment must be products of a single manufacturer. Each major component of equipment must have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products must have been in a satisfactory commercial or industrial use for two years prior to use on this project. The two year use must include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement is acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items must be supported by a service organization. Items of the same type and purpose must be identical, including equipment, assemblies, parts and components.

2.2 PRODUCT DATA

Provide manufacturer's product data sheets documenting compliance with product specifications for each product provided under Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, or this Section. Provide product data for all products in a single indexed compendium, organized by product type.

For all BACnet hardware: for each manufacturer, model and version (revision) of DDC Hardware provide the Protocol Implementation Conformance Statement (PICS) in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

Submit Manufacturer's Product Data on CD-ROM.

2.3 OPERATION ENVIRONMENT

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

a. Pressure: Pressure conditions normally encountered in the installed location.

b. Vibration: Vibration conditions normally encountered in the installed location.

c. Temperature:

(1) Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

(2) Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

d. Humidity: 10 to 95 percent relative humidity, noncondensing and

humidity conditions outside this range normally encountered at the installed location.

2.4 WIRELESS CAPABILITY

Wireless capabilities must comply with Section 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC

2.5 ENCLOSURES

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

2.5.1 Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 Type 3 requirements.

2.5.2 Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 Type 2 requirements.

2.5.3 Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.6 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.6.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.6.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.6.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.6.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.6.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

PART 3 EXECUTION

3.1 INSTALLATION

Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS for BACnet or Niagara BACnet systems, and this Section.

3.1.1 Dielectric Isolation

Provide dielectric isolation where dissimilar metals are used for connection and support. Install control system in a matter that provides clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Install control system such that it does not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.2 Penetrations in Building Exterior

Make all penetrations through and mounting holes in the building exterior watertight.

3.1.3 Device Mounting Criteria

Install devices in accordance with the manufacturer's recommendations and as indicated and shown. Provide a weathershield for all devices installed outdoors. Provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Provide clearance for mechanical and electrical system maintenance; do not not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.4 Labels and Tags

Key all labels and tags to the unique identifiers shown on the As-Built drawings. For labels exterior to protective enclosures provide engraved plastic labels mechanically attached to the enclosure or DDC Hardware.

Labels inside protective enclosures may be attached using adhesive, but must not be hand written. For tags, provide plastic or metal tags mechanically attached directly to each device or attached by a metal chain or wire.

a. Label all Enclosures and DDC Hardware.

b. Tag Airflow measurement arrays (AFMA) with flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient.

c. Tag duct static pressure taps at the location of the pressure tap

3.1.5 Surge Protection

3.1.5.1 Power-Line Surge Protection

Protect equipment connected to AC circuits to withstand power-line surges in accordance with IEEE C62.41. Do not use fuses for surge protection.

3.1.5.2 Surge Protection for Transmitter and Control Wiring

Protect DDC hardware against or provided DDC hardware capable of withstanding surges induced on control and transmitter wiring installed outdoors and as shown. Protect equipment against the following two waveforms:

a. A waveform with a 10-microsecond rise time, a 1000-microsecond decay time and a peak current of 60 amps.

b. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

3.1.6 Basic Cybersecurity Requirements

3.1.6.1 Passwords

Password development and the Password Summary Report submittal must comply with Section 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC.

3.1.6.2 Wireless Capability

Wireless capabilities must comply with Section 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC.

3.1.6.3 IP Network Physical Security

IP network physical security must comply with Section 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC.

3.2 DRAWINGS AND CALCULATIONS

Provide drawings in the form and arrangement indicated and shown. Use the same abbreviations, symbols, nomenclature and identifiers shown. Assign a unique identifier as shown to each control system element on a drawing. When packaging drawings, group schedules by system. When space allows, it is permissible to include multiple schedules for the same system on a single sheet. Except for drawings covering all systems, do not put information for different systems on the same sheet.

Submit hardcopy drawings on A3 17 by 11 inches sheets, and electronic drawings in PDF and in AutoCAD or Microstation format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

Submit DDC Contractor Design Drawings consisting of each drawing indicated with pre-construction information depicting the intended control system design and plans. Submit DDC Contractor Design Drawings as a single complete package: 2 hard copies and 2 copies on CD-ROM.</OLI>

Submit Draft As-Built Drawings consisting of each drawing indicated updated with as-built data for the system prior to PVT. Submit Draft As-Built Drawings as a single complete package: 2 hard copies and 2 copies on CD-ROM.

Submit Final As-Built Drawings consisting of each drawing indicated updated with all final as-built data. Final As-Built Drawings as a single complete package: 2 hard copies and 2 copies on CD-ROM.

3.2.1 Sample Drawings

Sample drawings in electronic format are available at the Whole Building Design Guide page for this section: http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-23-09-00 These drawings may prove useful in demonstrating expected drawing formatting and example content and are provided for illustrative purposes only. Note that these drawings do not meet the content requirements of this Section and must be completed to meet project requirements.

3.2.2 Drawing Index and Legend

Provide an HVAC Control System Drawing Index showing the name and number of the building, military site, State or other similar designation, and Country. In the Drawing Index, list all Contractor Design Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. In the Design Drawing Legend, show and describe all symbols, abbreviations and acronyms used on the Design Drawings. Provide a single Index and Legend for the entire drawing package.

3.2.3 Thermostat and Occupancy Sensor Schedule

Provide a thermostat and occupancy sensor schedule containing each thermostat's unique identifier, room identifier and control features and functions as shown. Provide a single thermostat and occupancy sensor schedule for the entire project.

3.2.4 Valve Schedule

Provide a valve schedule containing each valve's unique identifier, size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. In the valve schedule include actuator selection data supported by calculations of the force required to move and seal the valve, access and clearance requirements. Provide a single valve schedule for the entire project.

3.2.5 Damper Schedule

Provide a damper schedule containing each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. Include the AMCA 511 maximum leakage rate at the operating static-pressure differential for each damper in the Damper Schedule. Provide a single damper schedule for the entire project.

3.2.6 Project Summary Equipment Schedule

Provide a project summary equipment schedule containing the manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a single project equipment schedule for the entire project.

3.2.7 Equipment Schedule

Provide system equipment schedules containing the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a separate equipment schedule for each HVAC system.

3.2.8 Occupancy Schedule

Provide an occupancy schedule drawing containing the same fields as the occupancy schedule Contract Drawing with Contractor updated information. Provide a single occupancy schedule for the entire project.

3.2.9 DDC Hardware Schedule

Provide a single DDC Hardware Schedule for the entire project and including following information for each device.

3.2.9.1 DDC Hardware Identifier

The Unique DDC Hardware Identifier for the device.

3.2.9.2 HVAC System

The system "name" used to identify a specific system (the name used on the system schematic drawing for that system).

3.2.9.3 BACnet Device Information

3.2.9.3.1 Device Object Identifier

The Device Object Identifier: The Object_Identifier of the Device Object

3.2.9.3.2 Network Number

The Network Number for the device.

3.2.9.3.3 MAC Address

The MAC Address for the device

3.2.9.3.4 BTL Listing

The BTL Listing of the device. If the device is listed under multiple BTL Profiles, indicate the profile that matches the use and configuration of the device as installed.

3.2.9.3.5 Proprietary Services Information

If the device uses non-standard ASHRAE 135 services as defined and permitted in Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, indicate that the device uses non-standard services and include a description of all non-standard services used. Describe usage and content such that a device from another vendor can interoperate with the device using the non-standard service. Provide descriptions with sufficient detail to allow a device from a different manufacturer to be programmed to both read and write the non-standard service request:

a. read: interpret the data contained in the non-standard service and;

b. write: given similar data, generate the appropriate non-standard service request.

3.2.9.3.6 Alarming Information

Indicate whether the device is used for alarm generation, and which types of alarm generation the device implements: intrinsic, local algorithmic, remote algorithmic.

3.2.9.3.7 Scheduling Information

Indicate whether the device is used for scheduling.

3.2.9.3.8 Trending Information

Indicate whether the device is used for trending, and indicate if the device is used to trend local values, remote values, or both.

3.2.9.4 Niagara Station ID

The Niagara Station ID for each Niagara Framework Supervisory Gateway

3.2.10 Points Schedule

Provide a Points Schedule in tabular form for each HVAC system, with the indicated columns and with each row representing a hardware point, network point or configuration point in the system.

a. When a Points Schedule was included in the Contract Drawing package, use the same fields as the Contract Drawing with updated information in addition to the indicated fields.

b. When Point Schedules are included in the contract package, items requiring contractor verification or input have been shown in angle brackets ("<" and ">"), such as <___> for a required entry or <value> for a value requiring confirmation. Complete all items in brackets as well as any blank cells. Do not modify values which are not in

brackets without approval.

Points Schedule Columns must include:

3.2.10.1 Point Name

The abbreviated name for the point using the indicated naming convention.

3.2.10.2 Description

A brief functional description of the point such as "Supply Air Temperature".

3.2.10.3 DDC Hardware Identifier

The Unique DDC Hardware Identifier shown on the DDC Hardware Schedule and used across all drawings for the DDC Hardware containing the point.

3.2.10.4 Settings

The value and units of any setpoints, configured setpoints, configuration parameters, and settings related to each point.

3.2.10.5 Range

The range of values, including units, associated with the point, including but not limited to a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety.

3.2.10.6 Input or Output (I/O) Type

The type of input or output signal associated with the point. Use the following abbreviations for entries in this column:

a. AI: The value comes from a hardware (physical) Analog Input

b. AO: The value is output as a hardware (physical) Analog Output

c. BI: The value comes from a hardware (physical) Binary Input

d. BO: The value is output as a hardware (physical) Binary Output

e. PULSE: The value comes from a hardware (physical) Pulse Accumulator Input

f. NET-IN: The value is provided from the network (generally from another device). Use this entry only when the value is received from another device as part of scheduling or as part of a sequence of operation, not when the value is received on the network for supervisory functions such as trending, alarming, override or display at a user interface.

g. NET-OUT: The value is provided to another controller over the network. Use this entry only when the value is transmitted to another device as part of scheduling or as part of a sequence of operation, not when the value is transmitted on the network for supervisory functions such as trending, alarming, override or display at a user interface.

3.2.10.7 Object and Property Information

The Object Type and Instance Number for the Object associated with the point. If the value of the point is not in the Present_Value Property, then also provide the Property ID for the Property containing the value of the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

3.2.10.8 Niagara Station ID

The Niagara Station ID of the Niagara Framework Supervisory Gateway the point is mapped into.

3.2.10.9 Network Data Exchange Information (Gets Data From, Sends Data To)

Provide the DDC Hardware Identifier of other DDC Hardware the point is shared with.

3.2.10.10 Override Information (Object Type and Instance Number)

For each point requiring an Override and not residing in a Niagara Framework Supervisory Gateway, indicate if the Object for the point is Commandable or, if the use of a separate Object was specifically approved by the Contracting Officer, provide the Object Type and Instance Number of the Object to be used in overriding the point.

3.2.10.11 Alarm Information

For Niagara BACnet systems: Indicate the Alarm Generation Type and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have a Notification Class Object.)

3.2.10.12 Configuration Information

Indicate the means of configuration associated with each point. For points in a Niagara Framework Supervisory Gateway, indicate the point within the Niagara Framework Supervisory Gateway used to configure the value. For other points:

a. For Operator Configurable Points indicate BACnet Object and Property information (Name, Type, Identifiers) containing the configurable value. Indicate whether the property is writable always, or only when Out_Of_Service is TRUE.

b. For Configurable Points indicate the BACnet Object and Property information as for Operator Configurable points, or identification of the configurable settings from within the engineering software for the device or identification of the hardware settings on the device.

3.2.11 Riser Diagram

The Riser Diagram of the Building Control Network may be in tabular form, and must show all DDC Hardware and all Network Hardware, including network terminators. For each item, provide the unique identifier, common descriptive name, physical sequential order (previous and next device on the network), room identifier and location within room. A single riser diagram must be submitted for the entire system.

3.2.12 Control System Schematics

Provide control system schematics in the same form as the control system schematic Contract Drawing with Contractor updated information. Provide a control system schematic for each HVAC system.

3.2.13 Sequences of Operation

Provide HVAC control system sequence of operation and in the same format as the Contract Drawings. Within these drawings, refer to devices by their unique identifiers. Submit sequences of operation for each HVAC system

3.2.14 Controller, Motor Starter and Relay Wiring Diagram

Provide controller wiring diagrams as functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. Show necessary jumpers and ground connections and the labels of all conductors. Identify sources of power required for control systems and for packaged equipment control systems back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Show each power supply and transformer not integral to a controller, starter, or packaged equipment. Show the connected volt-ampere load and the power supply volt-ampere rating. Provide wiring diagrams for each HVAC system.

3.3 CONTROLLER TUNING

Tune each controller in a manner consistent with that described in the ASHRAE FUN IP and in the manufacturer's instruction manual. Tuning must consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop must be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable must settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output must be steady. With the exception of naturally slow processes such as zone temperature control, the controller must settle out at the new setpoint within five (5) minutes. Set the controller to its correct setpoint and record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.4 START-UP

3.4.1 Start-Up Test

Perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

Adjust, calibrate, measure, program, configure, set the time schedules, and otherwise perform all necessary actions to ensure that the systems function as indicated and shown in the sequence of operation and other contract documents.

3.4.1.1 Systems Check

An item-by-item check must be performed for each HVAC system

3.4.1.1.1 Step 1 - System Inspection

With the system in unoccupied mode and with fan hand-off-auto switches in the OFF position, verify that power and main air are available where required and that all output devices are in their failsafe and normal positions. Inspect each local display panel and each M&C Client to verify that all displays indicate shutdown conditions.

3.4.1.1.2 Step 2 - Calibration Accuracy Check

Perform a two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter by comparing the value from the test instrument to the network value provided by the DDC Hardware. Use digital indicating test instruments, such as digital thermometers, motor-driven psychrometers, and tachometers. Use test instruments with accuracy at least twice as accurate as the specified sensor accuracy and with calibration traceable to National Institute of Standards and Technology standards. Check one the first check point in the bottom one-third of the sensor range, and the second in the top one-third of the sensor range. Verify that the sensing element-to-DDC readout accuracies at two points are within the specified product accuracy tolerances, and if not recalibrate or replace the device and repeat the calibration check.

3.4.1.1.3 Step 3 - Actuator Range Check

With the system running, apply a signal to each actuator through the DDC Hardware controller. Verify proper operation of the actuators and positioners for all actuated devices and record the signal levels for the extreme positions of each device. Vary the signal over its full range, and verify that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, verify that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. For valve actuators and damper actuators, perform the actuator range check under normal system pressures.

3.4.1.2 Weather Dependent Test

Perform weather dependent test procedures in the appropriate climatic season.

3.4.2 Start-Up Testing Report

Submit 2 copies of the Start-Up Testing Report. The report may be submitted as a Technical Data Package documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

3.5 PERFORMANCE VERIFICATION TEST (PVT)

3.5.1 PVT Procedures

Prepare PVT Procedures based on Section 25 08 10 UTILITY MONITORING AND

CONTROL SYSTEM TESTING explaining step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. Submit 2 copies of the PVT Procedures. The PVT Procedures may be submitted as a Technical Data Package.

3.5.1.1 Sensor Accuracy Checks

Include a one-point accuracy check of each sensor in the PVT procedures.

3.5.1.2 Endurance Test

Include a one-week endurance test as part of the PVT during which the system is operated continuously.

Use the building control system Niagara Trend Log Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost.

3.5.1.3 PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment, include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration

3.5.2 PVT Execution

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, software capable of reading and writing COV Notification Subscriptions, Notification Class Recipient List Properties, event enrollments, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. Do not start the performance verification test until after receipt of written permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. If the system experiences any failures during the endurance test portion of the PVT, repair the system repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period.

3.5.3 PVT Report

Prepare and submit a PVT report documenting all tests performed during the PVT and their results. Include all tests in the PVT procedures and any additional tests performed during PVT. Document test failures and repairs conducted with the test results.

Submit 2 copies of the PVT Report. The PVT Report may be submitted as a Technical Data Package.

3.6 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

Provide HVAC control System Operation and Maintenance Instructions which include:

a. "Data Package 3" as indicated in Section 01 78 23 OPERATION AND MAINTENANCE DATA for each piece of control equipment.

b. "Data Package 4" as described in Section 01 78 23 OPERATION AND MAINTENANCE DATA for all air compressors.

c. HVAC control system sequences of operation formatted as indicated.

d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.

e. As-built HVAC control system detail drawings formatted as indicated.

f. Routine maintenance checklist. Provide the routine maintenance checklist arranged in a columnar format, where the first column lists all installed devices, the second column states the maintenance activity or that no maintenance required, the third column states the frequency of the maintenance activity, and the fourth column is used for additional comments or reference.

g. Qualified service organization list, including at a minimum company name, contact name and phone number.

h. Start-Up Testing Report.

i. Performance Verification Test (PVT) Procedures and Report.

Submit 2 copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions may be submitted as a Technical Data Package.

3.7 TRAINING

Conduct a training course for 4 operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. Conduct 16 hours of training at the project site within 30 days after successful completion of the performance verification test. The Government reserves the right to make audio and visual recordings (using Government supplied equipment)of the training sessions for later use. Provide audiovisual equipment and other training materials and supplies required to conduct training. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.7.1 Training Documentation

Prepare training documentation consisting of:

a. Course Attendee List: Develop the list of course attendees in coordination with and signed by the Controls shop supervisor.

b. Training Manuals: Provide training manuals which include an agenda,

defined objectives for each lesson, and a detailed description of the subject matter for each lesson. When presenting portions of the course material by audiovisuals, deliver copies of those audiovisuals as a part of the printed training manuals.

3.7.2 Training Course Content

For guidance in planning the required instruction, assume that attendees will have a high school education, and are familiar with HVAC systems. During the training course, cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. Present the results of the performance verification test and the Start-Up Testing Report as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

3.7.3 Training Documentation Submittal Requirements

Submit hardcopy training manuals and all training materials on CD-ROM. Provide one hardcopy manual for each trainee on the Course Attendee List and 2 additional copies for archive at the project site. Provide 2 copies of the Course Attendee List with the archival copies. Training Documentation may be submitted as a Technical Data Package.

APPENDIX A

QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS		
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.		
This checklist is for (circle one:) Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal		
Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:		
1	All DDC Hardware is numbered on Control System Schematic Drawings.	|____|
2	Signal lines on Control System Schematic are labeled with the signal type.	|____|
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.	|____|
Items verified for Post-Construction and Closeout QC Checklist Submittals:		
4	All sequences are performed as specified using DDC Hardware.	|____|
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.	|____|
Items verified for Closeout QC Checklist Submittal:		
6	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.	|____|
7	Programming software has been submitted for all programmable controllers.	|____|
8	All software has been licensed to the Government.	

	QC CHECKLIST FOR NIAGARA FRAMEWORK BASED BACNET SYSTEMS	
9	O&M Instructions have been completed and submitted.	|____|
10	Training course has been completed.	|____|
11	All DDC Hardware is installed on a BACnet ASHRAE 135 network using either MS/TP in accordance with Clause 9 or IP in accordance with Annex J.	|____|
12	All DDC Hardware is BTL listed.	|____|
13	Communication between DDC Hardware is only via BACnet using standard services, except as specifically permitted by the specification. Non-standard services have been fully documented in the DDC Hardware Schedule.	|____|
14	Scheduling, Alarming, and Trending have been implemented using Niagara Framework objects and services, and BACnet Instrinsic Alarming as indicated.	|____|
15	All Properties indicated as required to be Writable are Writable and Overrides have been provided as indicated	|____|
	_____ _____	
	(QC Representative Signature) (Date)	

-- End of Section --

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SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
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PART 1 GENERAL

1.1 SUMMARY

This section provides for the instrumentation control system components excluding direct digital controllers, network controllers, gateways etc. that are necessary for a completely functional automatic control system. When combined with a Direct Digital Control (DDC) system, the Instrumentation and Control Devices covered under this section must be a complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and indicated.

a. Install hardware to perform the control sequences as specified and indicated and to provide control of the equipment as specified and indicated.

b. Install hardware such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

c. Install and configure hardware such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the installing Contractor.

1.1.1 Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.1.2 Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.2 RELATED SECTIONS

Related work specified elsewhere.

Section 23 30 00 HVAC AIR DISTRIBUTION

Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating
AMCA 511	(2010; R 2016) Certified Ratings Program for Air Control Devices

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B40.100	(2022) Pressure Gauges and Gauge Attachments

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems

UL SOLUTIONS (UL)

UL 5085-3	(2006; Reprint Jan 2022) UL Standard for Safety Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.4 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Submittal requirements are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.5 DELIVERY AND STORAGE

Store and protect products from the weather, humidity, and temperature

variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.6 INPUT MEASUREMENT ACCURACY

Select, install and configure sensors, transmitters and DDC Hardware such that the maximum error of the measured value at the input of the DDC hardware is less than the maximum allowable error specified for the sensor or instrumentation.

1.7 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section in accordance with the paragraph entitled CONTRACTOR SPECIAL REQUIREMENTS in Section 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 General Requirements

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.1.2 Operation Environment Requirements

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

2.1.2.1 Pressure

Pressure conditions normally encountered in the installed location.

2.1.2.2 Vibration

Vibration conditions normally encountered in the installed location.

2.1.2.3 Temperature

a. Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

b. Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

2.1.2.4 Humidity

10 to 95 percent relative humidity, non-condensing and also humidity conditions outside this range normally encountered at the installed location.

2.2 WEATHERSHIELDS

Provide weathershields constructed of galvanized steel painted white, unpainted aluminum, aluminum painted white, or white PVC.

2.3 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

2.3.1 Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

2.3.2 Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

2.3.3 Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

a. minimum 2 inch lay of twist

b. 100 percent shielded pairs

c. at least 300-volt insulation

d. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

e. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.3.4 Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

2.3.5 Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

2.4 DAMPERS

2.4.1 Damper Assembly

Provide single damper sections with blades no longer than 48 inches and

which are no higher than 72 inches and damper blade width of 8 inches or less. When larger sizes are required, combine damper sections. Provide dampers made of steel, or other materials where indicated and with assembly frames constructed of 0.07 inch minimum thickness galvanized steel channels with mitered and welded corners. Steel channel frames constructed of 0.06 inch minimum thickness are acceptable provided the corners are reinforced.

a. Flat blades must be made rigid by folding the edges. Blade-operating linkages must be within the frame so that blade-connecting devices within the same damper section must not be located directly in the air stream.

b. Damper axles must be 1/2 inch minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically must be supported by thrust bearings.

c. Provide dampers which do not exceed a pressure drop through the damper of 0.04 inches water gauge at 1000 ft/min in the wide-open position. Provide dampers with frames not less than 2 inch in width. Provide dampers which have been tested in accordance with AMCA 500-D.

2.4.2 Operating Linkages

For operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, provide links able to withstand a load equal to at least 300 percent of the maximum required damper-operating force without deforming. Rod lengths must be adjustable. Links must be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises must be brass, bronze, or stainless steel. Adjustments of crank arms must control the open and closed positions of dampers.

2.4.3 Damper Types

2.4.3.1 Flow Control Dampers

Provide parallel-blade or opposed blade type dampers for outside air, return air, relief air, exhaust, face and bypass dampers as indicated on the Damper Schedule. Blades must have interlocking edges. The channel frames of the dampers must be provided with jamb seals to minimize air leakage. Unless otherwise indicated, dampers must meet AMCA 511 Class 1 requirements. Outside air damper seals must be suitable for an operating temperature range of -40 to +167 degrees F. Dampers must be rated at not less than 2000 ft/min air velocity.

2.4.3.2 Mechanical Rooms and Other Utility Space Ventilation Dampers

Provide utility space ventilation dampers as indicated. Unless otherwise indicated provide AMCA 511 class 3 dampers. Provide dampers rated at not less than 1500 ft/min air velocity.

2.5 SENSORS AND INSTRUMENTATION

Unless otherwise specified, provide sensors and instrumentation which incorporate an integral transmitter. Sensors and instrumentation, including their transmitters, must meet the specified accuracy and drift requirements at the input of the connected DDC Hardware's analog-to-digital conversion.

2.5.1 Analog and Binary Transmitters

Provide transmitters which match the characteristics of the sensor. Transmitters providing analog values must produce a linear 4-20 mAdc, 0-10 Vdc signal corresponding to the required operating range and must have zero and span adjustment. Transmitters providing binary values must have dry contacts rated at 1A at 24 Volts AC.

2.5.2 Network Transmitters

Sensors and Instrumentation incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS when used in a BACnet network.

2.5.3 Temperature Sensors

Provide the same sensor type throughout the project. Temperature sensors may be provided without transmitters. Where transmitters are used, the range must be the smallest available from the manufacturer and suitable for the application such that the range encompasses the expected range of temperatures to be measured. The end to end accuracy includes the combined effect of sensitivity, hysteresis, linearity and repeatability between the measured variable and the end user interface (graphic presentation) including transmitters if used.

2.5.3.1 Sensor Accuracy and Stability of Control

2.5.3.1.1 Conditioned Space Temperature

Plus or minus 0.5 degree F over the operating range.

2.5.3.1.2 Unconditioned Space Temperature

a. Plus or minus 1 degree F over the range of 30 to 131 degrees F AND

b. Plus or minus 4 degrees F over the rest of the operating range.

2.5.3.1.3 Duct Temperature

Plus or minus 0.5 degree F

2.5.3.1.4 Outside Air Temperature

a. Plus or minus 2 degrees F over the range of -30 to +130 degrees F AND

b. Plus or minus 1 degree F over the range of 30 to 130 degrees F.

2.5.3.2 Transmitter Drift

The maximum allowable transmitter drift: 0.25 degrees F per year.

2.5.3.3 Point Temperature Sensors

Point Sensors must be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper.

2.5.3.4 Temperature Sensor Details

2.5.3.4.1 Room Type

Provide the sensing element components within a decorative protective cover suitable for surrounding decor.

2.5.3.4.2 Duct Probe Type

Ensure the probe is long enough to properly sense the air stream temperature.

2.5.3.4.3 Duct Averaging Type

Continuous averaging sensors must be one foot in length for each 1 square foot of duct cross-sectional area, and a minimum length of 5 feet.

2.5.3.4.4 Outside Air Type

Provide the sensing element rated for outdoor use

2.5.4 Differential Pressure Instrumentation

2.5.4.1 Differential Pressure Sensors

Provide Differential Pressure Sensors with ranges as indicated or as required for the application. Pressure sensor ranges must not exceed the high end range indicated on the Points Schedule by more than 50 percent. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The accuracy must be plus or minus 1 percent of full scale. The sensor must have a maximum drift of 2 percent per year

2.5.4.2 Differential Pressure Switch

Provide differential pressure switches with a user-adjustable setpoint which are sized for the application such that the setpoint is between 25 percent and 75 percent of the full range. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The switch must have two sets of contacts and each contact must have a rating greater than it's connected load. Contacts must open or close upon rise of pressure above the setpoint or drop of pressure below the setpoint as indicated.

2.5.5 Flow Sensors

2.5.5.1 Airflow Measurement Array (AFMA)

2.5.5.1.1 Airflow Straightener

Provide AFMAs which contain an airflow straightener if required by the AFMA manufacturer's published installation instructions. The straightener must be contained inside a flanged sheet metal casing, with the AFMA located as specified according to the published recommendation of the AFMA manufacturer. In the absence of published documentation, provide airflow straighteners if there is any duct obstruction within 5 duct diameters upstream of the AFMA. Air-flow straighteners, where required, must be constructed of 0.125 inch aluminum honeycomb and the depth of the straightener must not be less than 1.5 inches.

2.5.5.1.2 Resistance to Airflow

The resistance to air flow through the AFMA, including the airflow straightener must not exceed 0.085 inch water gauge at an airflow of 2,000 fpm. AFMA construction must be suitable for operation at airflows of up to 5000 fpm over a temperature range of 40 to 120 degrees F.

2.5.5.1.3 Outside Air Temperature

In outside air measurement or in low-temperature air delivery applications, provide an AFMA certified by the manufacturer to be accurate as specified over a temperature range of -20 to +120 degrees F .

2.5.5.1.4 Pitot Tube AFMA

Each Pitot Tube AFMA must contain an array of velocity sensing elements. The velocity sensing elements must be of the multiple pitot tube type with averaging manifolds. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published installation instructions of the AFMA manufacturer.

a. Pitot Tube AFMAs for use in airflows over 600 fpm must have an accuracy of plus or minus 5 percent over a range of 500 to 2500 fpm.

b. Pitot Tube AFMAs for use in airflows under 600 fpm must have an accuracy of plus or minus 5 percent over a range of 125 to 2500 fpm.

2.5.5.1.5 Electronic AFMA

Each electronic AFMA must consist of an array of velocity sensing elements of the resistance temperature detector (RTD) or thermistor type. The sensing elements must be distributed across the duct cross section in the quantity and pattern specified or recommended by the published application data of the AFMA manufacturer. Electronic AFMAs must have an accuracy of plus or minus 5 percent over a range of 125 to 5,000 fpm and the output must be temperature compensated over a range of 32 to 212 degrees F.

2.5.5.1.6 Fan Inlet Measurement Devices

Fan inlet measurement devices cannot be used unless indicated on the drawings or schedules.

2.5.5.2 Orifice Plate

Orifice plate must be made of an austenitic stainless steel sheet of 0.125 inch nominal thickness with an accuracy of plus or minus 1 percent of full flow. The orifice plate must be flat within 0.002 inches. The orifice surface roughness must not exceed 20 micro-inches. The thickness of the cylindrical face of the orifice must not exceed 2 percent of the pipe inside diameter or 12.5 percent of the orifice diameter, whichever is smaller. The upstream edge of the orifice must be square and sharp. Where orifice plates are used, concentric orifice plates must be used in all applications except steam flow measurement in horizontal pipelines.

2.5.5.3 Flow Nozzle

Flow nozzle must be made of austenitic stainless steel with an accuracy of plus or minus 1 percent of full flow. The inlet nozzle form must be

elliptical and the nozzle throat must be the quadrant of an ellipse. The thickness of the nozzle wall and flange must be such that distortion of the nozzle throat from strains caused by the pipeline temperature and pressure, flange bolting, or other methods of installing the nozzle in the pipeline must not cause the accuracy to degrade beyond the specified limit. The outside diameter of the nozzle flange or the design of the flange facing must be such that the nozzle throat must be centered accurately in the pipe.

2.5.5.4 Venturi Tube

Venturi tube must be made of cast iron or cast steel and must have an accuracy of plus or minus 1 percent of full flow. The throat section must be lined with austenitic stainless steel. Thermal expansion characteristics of the lining must be the same as that of the throat casting material. The surface of the throat lining must be machined to a plus or minus 50 micro inch finish, including the short curvature leading from the converging entrance section into the throat.

2.5.5.5 Annular Pitot Tube

Annular pitot tube must be made of austenitic stainless steel with an accuracy of plus or minus 2 percent of full flow and a repeatability of plus or minus 0.5 percent of measured value. The unit must have at least one static port and no less than four total head pressure ports with an averaging manifold.

2.5.5.6 Insertion Turbine Flowmeter

Provide dual axial turbine flowmeter with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Insertion Turbine Flowmeter accuracy must be plus or minus 0.5 percent of rate at calibrated velocity., within plus or minus of rate over a 10:1 turndown and within plus or minus 2 percent of rate over a 50:1 turndown. Repeatability must be plus or minus 0.25 percent of reading. The meter flow sensing element must operate over a range suitable for the installed location with a pressure loss limited to 1 percent of operating pressure at maximum flow rate. The flowmeter ,must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs. The turbine rotor assembly must be constructed of Series 300 stainless steel and use Teflon seals.

2.5.5.7 Vortex Shedding Flowmeter

Vortex Shedding Flowmeter accuracy must be within plus or minus 0.8 percent of the actual reading over the range of the meter. Steam meters must contain density compensation by direct measurement of temperature. Mass flow inferred from specified steam pressure are not acceptable. The flow meter body must be made of austenitic stainless steel and include a weather tight NEMA 4X electronics enclosure. The vortex shedding flowmeter body must not require removal from the piping in order to replace the shedding sensor.

2.5.5.8 Ultrasonic Flow Meter

Provide Ultrasonic Flow Meters complete with matched transducers, self aligning installation hardware and transducer cables. Ultrasonic transducers must be optimized for the specific pipe and process conditions

for the application. The flow meter accuracy must plus or minus 1 percent of rate from 0 to 40 ft/sec. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc output.

2.5.5.9 Insertion Magnetic Flow Meter

Provide insertion type magnetic flowmeters with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Flowmeter accuracy must be no greater than plus or minus 1 percent of rate from 2 to 20 feet/sec. Wetted material parts must be 300 series stainless steel. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs.

2.5.5.10 Positive Displacement Flow Meter

The flow meter must be a direct reading, gerotor, nutating disc or vane type displacement device rated for liquid service as indicated. A counter must be mounted on top of the meter, and must consist of a non-resettable mechanical totalizer for local reading, and a pulse transmitter for remote reading. The totalizer must have a six digit register to indicate the volume passed through the meter in gallons, and a sweep-hand dial to indicate down to 0.25 gallons. The pulse transmitter must have a hermetically sealed reed switch which is activated by magnets fixed on gears of the counter. The meter must have a bronze body with threaded or flanged connections as required for the application. Output accuracy must be plus or minus 2 percent of the flow range. The maximum pressure drop at full flow must be 5 psig.

2.5.5.11 Flow Meters, Paddle Type

Sensor must be non-magnetic, with forward curved impeller blades designed for water containing debris. Sensor accuracy must be plus or minus 1 percent of rate of flow, minimum operating flow velocity must be 1 foot per second. Sensor repeatability and linearity must be plus or minus 1 percent. Materials which will be wetted must be made from non-corrosive materials and must not contaminate water. The sensor must be rated for installation in pipes of 3 to 40 inch diameters. The transmitter housing must be a NEMA 250 Type 4 enclosure.

2.5.5.12 Flow Switch

Flow switch must have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation must be adjustable over the operating flow range, and must be sized for the application such that the setpoint is between 25 percent and 75 percent of the full range.. The switch must have Form C snap-action contacts, rated for the application. The flow switch must have non flexible paddle with magnetically actuated contacts and be rated for service at a pressure greater than the installed conditions. Flow switch for use in sewage system must be rated for use in corrosive environments encountered.

2.5.6 Electrical Instruments

Provide Electrical Instruments with an input range as indicated or sized for the application. Unless otherwise specified, AC instrumentation must be suitable for 60 Hz operation.

2.5.6.1 Current Transducers

Current transducers must accept an AC current input and must have an accuracy of plus or minus 0.5 percent of full scale. The device must have a means for calibration. Current transducers for variable frequency applications must be rated for variable frequency operation.

2.5.6.2 Current Sensing Relays (CSRs)

Current sensing relays (CSRs) must provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays must be of split-core design. The CSR must be rated for operation at 200 percent of the connected load. Voltage isolation must be a minimum of 600 volts. The CSR must auto-calibrate to the connected load or be adjustable and field calibrated. Current sensors for variable frequency applications must be rated for variable frequency operation.

2.5.6.3 Voltage Transducers

Voltage transducers must accept an AC voltage input and have an accuracy of plus or minus 0.25 percent of full scale. The device must have a means for calibration. Line side fuses for transducer protection must be provided.

2.5.6.4 Energy Metering

2.5.6.4.1 Watt or Watthour Transducers

Watt transducers must measure voltage and current and must output kW or kWh or both kW and kWh as indicated. kW outputs must have an accuracy of plus or minus 0.5 percent over a power factor range of 0.1 to 1. kWh outputs must have an accuracy of plus or minus 0.5 percent over a power factor range of 0.1 to 1.

2.5.7 Occupancy Sensors

Refer to division 26 specifications.

2.5.8 Temperature Switch

2.5.8.1 Duct Mount Temperature Low Limit Safety Switch (Freezestat)

Duct mount temperature low limit switches (Freezestats) must be manual reset, low temperature safety switches at least 1 foot long per square foot of coverage which must respond to the coldest 18 inch segment with an accuracy of plus or minus 3.6 degrees F. The switch must have a field-adjustable setpoint with a range of at least 30 to 50 degrees F. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon drop of temperature below setpoint as indicated and must remain in this state until reset.

2.5.9 Damper End Switches

Each end switch must be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure must be suitable for mounting on the duct exterior and must permit setting the position of the trip lever that actuates the switch. The trip lever must be aligned with the damper blade.

End switches integral to an electric damper actuator are allowed as long as at least one is adjustable over the travel of the actuator.

2.6 INDICATING DEVICES

All indicating devices must display readings in English (inch-pound) units.

2.6.1 Thermometers

Provide bi-metal type thermometers at locations indicated. Thermometers must have either 9 inch long scales or 3.5 inch diameter dials, with insertion, immersion, or averaging elements. Provide matching thermowells for pipe-mounted installations. Select scale ranges suitable for the intended service, with the normal operating temperature near the scale's midpoint. The thermometer's accuracy must be plus or minus 2 percent of the scale range.

2.6.1.1 Air-Duct Thermometers

Air-duct thermometers must have perforated stem guards and 45-degree adjustable duct flanges with locking mechanism.

2.6.2 Pressure Gauges

Provide pipe-mounted pressure gauges at the locations indicated. Gauges must conform to ASME B40.100 and have a 4 inch diameter dial and shutoff cock. Select scale ranges suitable for the intended service, with the normal operating pressure near the scale's midpoint. The gauge's accuracy must be plus or minus 2 percent of the scale range.

Gauges must be suitable for field or panel mounting as required, must have black legend on white background, and must have a pointer traveling through a 270-degree arc. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus 3 percent of scale range. Gauges must meet requirements of ASME B40.100.

2.6.3 Low Differential Pressure Gauges

Gauges for low differential pressure measurements must be a minimum of 3.5 inch (nominal) size with two sets of pressure taps, and must have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus two percent of scale range.

2.7 OUTPUT DEVICES

2.7.1 Actuators

Actuators must be electric (electronic) . All actuators must be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as indicated. Normally open and normally closed actuators must be of mechanical spring return type. Electric actuators must have an electronic cut off or other means to provide burnout protection if stalled. Actuators must have a visible position indicator. Electric actuators must provide position feedback to the controller as indicated. Actuators must smoothly and fully open or close the devices to which they are applied.

Electric actuators must have a full stroke response time in both directions of 90 seconds or less at rated load. Electric actuators must be of the foot-mounted type with an oil-immersed gear train or the direct-coupled type. Where multiple electric actuators operate from a common signal, the actuators must provide an output signal identical to its input signal to the additional devices. All actuators must be rated for their operating environment. Actuators used outdoors must be designed and rated for outdoor use. Actuators under continuous exposure to water, such as those used in sumps, must be submersible.

Actuators incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.7.1.1 Valve Actuators

Valve actuators must provide shutoff pressures and torques as indicated on the Valve Schedule.

2.7.1.2 Damper Actuators

Damper actuators must provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque must be at least 6 inch-pounds/1 square foot of damper area for opposed blade dampers and 9 inch-pounds/1 square foot of damper area for parallel blade dampers.

2.7.1.3 Electric Actuators

Each actuator must have distinct markings indicating the full-open and full-closed position Each actuator must deliver the torque required for continuous uniform motion and must have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators must function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds..

a. Two-position actuators must be single direction, spring return, or reversing type. Two position actuator signals may either be the control power voltage or line voltage as needed for torque or appropriate interlock circuits.

b. Modulating actuators must be capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators must be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Modulating actuator input signals can either be a 4 to 20 mAdc or a 0-10 VDC signal.

c. Floating or pulse width modulation actuators are acceptable for non-fail safe applications unless indicated otherwise provided that the floating point control (timed actuation) must have a scheduled re-calibration of span and position no more than once a day and no less than once a week. The schedule for the re-calibration should not affect occupied conditions and be staggered between equipment to prevent falsely loading or unloading central plant equipment.

2.7.2 Relays

Relays must have contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light must be lit when the coil is energized and off when coil is not energized.

Control relay contacts must have utilization category and ratings selected for the application. Each set of contacts must incorporate a normally open (NO), normally closed (NC) and common contact. Relays must be rated for a minimum life of one million operations.

2.8 USER INPUT DEVICES

User Input Devices, including potentiometers, switches and momentary contact push-buttons. Potentiometers must be of the thumb wheel or sliding bar type. Momentary Contact Push-Buttons may include an adjustable timer for their output. User input devices must be labeled for their function.

2.9 MULTIFUNCTION DEVICES

Multifunction devices are products which combine the functions of multiple sensor, user input or output devices into a single product. Unless otherwise specified, the multifunction device must meet all requirements of each component device. Where the requirements for the component devices conflict, the multifunction device must meet the most stringent of the requirements.

2.9.1 Current Sensing Relay Command Switch

The Current Sensing Relay portion must meet all requirements of the Current Sensing Relay input device. The Command Switch portion must meet all requirements of the Relay output device except that it must have at least one normally-open (NO) contact.

Current Sensing Relays used for Variable Frequency Drives must be rated for Variable Frequency applications unless installed on the source side of the drive. If used in this situation, the threshold for showing status must be set to allow for the VFD's control power when the drive is not enabled and provide indication of operation when the drive is enabled at minimum speed.

2.9.2 Space Sensor Module

Space Sensor Modules must be multifunction devices incorporating a temperature sensor and one or more of the following as specified and indicated on the Space Sensor Module Schedule:

a. A temperature indicating device.

b. A User Input Device which must adjust a temperature setpoint output.

c. A User Input Momentary Contact Button and an output to the control system indicating zone occupancy.

d. A three position User Input Switch labeled to indicate heating, cooling and off positions ('HEAT-COOL-OFF' switch) and providing corresponding outputs to the control system.

e. A two position User Input Switch labeled with 'AUTO' and 'ON' positions and providing corresponding output to the control system..

f. A multi-position User Input Switch with 'OFF' and at least two fan speed positions and providing corresponding outputs to the control system.

Space Sensor Modules cannot contain mercury (Hg).

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General Installation Requirements

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

3.1.1.1 Device Mounting Criteria

All devices must be installed in accordance with manufacturer's recommendations and as specified and indicated. Control devices to be installed in piping and ductwork must be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements must not be used except as specified. Spare thermowells must be installed adjacent to each thermowell containing a sensor and as indicated. Devices located outdoors must have a weathershield.

3.1.1.2 Labels and Tags

Match labels and tags to the unique identifiers indicated on the As-Built drawings. Label all enclosures and instrumentation. Tag all sensors and actuators in mechanical rooms. Tag airflow measurement arrays to show flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient. Tag duct static pressure taps at the location of the pressure tap. Provide plastic or metal tags, mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures must be engraved plastic and mechanically attached to the enclosure or instrumentation. Labels inside protective enclosures may attached using adhesive, but must not be hand written.

3.1.2 Weathershield

Provide weathershields for sensors located outdoors. Install weathershields such that they prevent the sun from directly striking the sensor and prevent rain from directly striking or dripping onto the sensor. Install weather shields with adequate ventilation so that the sensing element responds to the ambient conditions of the surroundings. When installing weathershields near outside air intake ducts, install them such that normal outside air flow does not cause rainwater to strike the sensor.

3.1.3 Room Instrument Mounting

Mount room instruments, including but not limited to wall mounted non-adjustable space sensor modules and sensors located in occupied spaces,

48 inches above the floor unless otherwise indicated. Install adjustable devices to be ADA compliant unless otherwise indicated on the Room Sensor Schedule:

a. Space Sensor Modules for Fan Coil Units may be either unit or wall mounted but not mounted on an exterior wall.

b. Wall mount all other Space Sensor Modules.

3.1.4 Switches

3.1.4.1 Temperature Limit Switch

Provide a temperature limit switch (freezestat) to sense the temperature at the location indicated. Provide a sufficient number of temperature limit switches (freezestats) to provide complete coverage of the duct section but no less than 1 foot in length per square foot of cross sectional area. Install manual reset limit switches in approved, accessible locations where they can be reset easily. Install temperature limit switch (freezestat) sensing elements in a side-to-side (not top-to-bottom) serpentine pattern with the relay section at the highest point and in accordance with the manufacturer's installation instructions.

3.1.4.2 Hand-Off Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

3.1.5 Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate and install sensors according to manufacturer’s instructions. Select sensors only for intended application as designated or recommended by manufacturer.

3.1.5.1 Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of all user-adjustable sensors 48 inches above the floor to meet ADA requirements. Non user-adjustable sensors can be mounted as indicated in paragraph ROOM INSTRUMENT MOUNTING.

3.1.5.2 Duct Temperature Sensors

3.1.5.2.1 Probe Type

Place tip of the sensor in the middle of the airstream or in accordance with manufacturer's recommendations or instructions.Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. When installed in insulated duct, provide enclosure or stand off fitting to accommodate the thickness of duct insulation to allow for maintenance or replacement of the sensor and wiring terminations. Seal the duct insulation penetration vapor tight.

3.1.5.2.2 Averaging Type

Weave the sensing element in a serpentine fashion from side to side perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports in accordance with manufacturer's installation instructions. Avoid tight radius bends or kinking of the sensing element. Prevent contact between the sensing element and the duct or air handler internals. Provide a duct access door at the sensor location. The access door must be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors must be fully accessible through the air handler's access doors without removing any of the air handler's internals.

3.1.5.3 Outside Air Temperature Sensors

Provide outside air temperature sensors on the building's north side with a protective weather shade that does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain. Location must not be near exhaust hoods and other areas such that it is not influenced by radiation or convection sources which may affect the reading. Provide a shield to shade the sensor from direct sunlight.

3.1.6 Air Flow Measurement Arrays (AFMA)

Locate Outside Air AFMAs downstream from the Outside Air filters.

Install AFMAs with the manufacturer's recommended minimum distances between upstream and downstream disturbances. Airflow straighteners may be used to reduce minimum distances as recommended by the AFMA manufacturer.

3.1.7 Meters

3.1.7.1 Energy Meters

Locate energy meters as indicated. Connect each meter output to the DDC system, to measure both instantaneous demand/energy and other variables as indicated.

3.1.8 Dampers

3.1.8.1 Damper Actuators

Provide spring return actuators which fail to a position that protects the served equipment and space on all control dampers related to freeze protection or force protection. For all outside, makeup and relief dampers provide dampers which fail closed. Terminal fan coil units, terminal VAV units, convectors, and unit heaters nay be non-spring return unless indicated otherwise. Do not mount actuators in the air stream. Do not connect multiple actuators to a common drive shaft. Install actuators so that their action seal the damper to the extent required to maintain leakage at or below the specified rate and so that they move the blades smoothly throughout the full range of motion.

3.1.8.2 Damper Installation

Install dampers straight and true, level in all planes, and square in all dimensions. Dampers must move freely without undue stress due to

twisting, racking (parallelogramming), bowing, or other installation error. External linkages must operate smoothly over the entire range of motion, without deformation or slipping of any connecting rods, joints or brackets that will prevent a return to it's normal position. Blades must close completely and leakage must not exceed that specified at the rated static pressure. Provide structural support for multi-section dampers. Acceptable methods of structural support include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers are installed in ducts or sleeves, they must not sag due to lack of support. Do not use jackshafts to link more than three damper sections. Do not use blade to blade linkages. Install outside and return air dampers such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

3.1.9 Valves

Install the valves in accordance with the manufacturer's instructions.

3.1.9.1 Valve Actuators

Provide spring return actuators on all control valves where freeze protection is required. Spring return actuators for terminal fan coil units, terminal VAV units, convectors, and unit heaters are not required unless indicated otherwise.

3.1.10 Thermometers and Gauges

3.1.10.1 Thermometers

Mount devices to allow reading while standing on the floor or ground, as applicable.

3.1.11 Wire and Cable

Provide complete electrical wiring for the Control System, including wiring to transformer primaries. Wire and Cable must be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Instrumentation grounding must be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Test installed ground rods as specified in IEEE 142. Cables and conductor wires must be tagged at both ends, with the identifier indicated on the shop drawings. Electrical work must be as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as indicated. Wiring external to enclosures must be run in raceways

Install control circuit wiring not in raceways in a neat and safe manner. Wiring must not use the suspended ceiling system (including tiles, frames or hangers) for support. Where conduit or raceways are required, control circuit wiring must not run in the same conduit/raceway as power wiring over 50 volts. Run all circuits over 50 volts in conduit, metallic tubing, covered metal raceways, or armored cable.

3.1.12 Copper Tubing

Provide hard-drawn copper tubing in exposed areas and either hard-drawn or annealed copper tubing in concealed areas. Use only tool-made bends. Use only brass or copper solder joint type fittings, except for connections

to apparatus. For connections to apparatus use brass compression type fittings.

3.1.13 Plastic Tubing

Install plastic tubing within covered raceways or conduit except when otherwise specified. Do not use plastic tubing for applications where the tubing could be subjected to a temperature exceeding 130 degrees F. For fittings, use brass or acetal resin of the compression or barbed push-on type for instrument service. Except in walls and exposed locations, plastic multitube instrument tubing bundle without conduit or raceway protection may be used where a number of air lines run to the same points, provided the multitube bundle is enclosed in a protective sheath, is run parallel to the building lines and is adequately supported as specified.

-- End of Section --

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SECTION 23 09 23.02

BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
08/24

PART 1 GENERAL

1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the front end which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown and in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.1.1 System Requirements

Provide a system meeting the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section and with the following characteristics:

a. Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 and Fox as the communications protocols. The system must use standard ASHRAE 135 Objects and Properties and the Niagara Framework. The system must use standard ASHRAE 135 Services and the Niagara Framework exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 or the Fox protocol exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two ASHRAE 135 devices on the Internetwork can communicate using standard ASHRAE 135 Services.

b. Install and configure control hardware to provide ASHRAE 135 Objects and Properties or Niagara Framework Objects as indicated and as needed to meet the requirements of this specification.

c. Use Niagara Framework hardware and software exclusively for scheduling, trending, and communication with a front end (UMCS). Use Niagara Framework or standard BACnet Objects and services for alarming. Use the Fox S (4911) protocol for all communication between Niagara Framework Supervisory Gateways; use the ASHRAE 135 protocol for all other building communication. Note that all communication using the Fox protocol must be secure (Fox S) and any reference to the Fox protocol in these specifications will imply secure/encrypted data transfer.

d. Use Niagara Framework Version 4.0 or later.

1.1.2 Verification of Specification Requirements

Review all specifications related to the control system installation and advise the Contracting Officer of any discrepancies before performing any work. If Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC or any

other Section referenced in this specification is not included in the project specifications advise the Contracting Officer and either obtain the missing Section or obtain Contracting Officer approval before performing any work.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks

BACNET TESTING LABORATORIES (BTL)

BTL Guide	(v.50; 2022) BACnet Testing Laboratory Implementation Guidelines

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3	(2022) Ethernet

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-485	(1998a; R 2012) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

TRIDIUM, INC (TRIDIUM)

Niagara Framework	(2021) NiagaraAX User's Guide
Tridium Open NiCS	(2021) Understanding the NiagaraAX Compatibility Statement (NiCS)

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 916	(2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment

1.3 DEFINITIONS

For definitions related to this section, see Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.4 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Submittal requirements related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

PART 2 PRODUCTS

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements of Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, Section 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC and this Section.

2.1 NETWORK HARDWARE

2.1.1 BACnet Router

All BACnet Routers must be BACnet/IP Routers and must perform layer 3 routing of ASHRAE 135 packets over an IP network in accordance with ASHRAE 135 Annex J and Clause 6. The router must provide the appropriate connection to the IP network and connections to one or more ASHRAE 135 MS/TP networks. Devices used as BACnet Routers must meet the requirements for DDC Hardware, and except for Niagara Framework Supervisory Gateways, devices used as BACnet routers must support the NM-RC-B BIBB.

2.1.2 BACnet Gateways

In addition to the requirements for DDC Hardware, the BACnet Gateway must be a Niagara Framework Supervisory Gateway or must meet the following requirements:

a. It must perform bi-directional protocol translation from one non-ASHRAE 135 protocol to ASHRAE 135. BACnet Gateways must incorporate a network connection to an ASHRAE 135 network (either BACnet over IP in accordance with Annex J or MS/TP) and a separate connection appropriate for the non-ASHRAE 135 protocol and media.

b. It must retain its configuration after a power loss of an indefinite time, and must automatically return to their pre-power loss state once power is restored.

c. It must allow bi-directional mapping of data between the non-ASHRAE 135 protocol and Standard Objects as defined in ASHRAE 135. It must support the DS-RP-B BIBB for Objects requiring read access and the DS-WP-B BIBB for Objects requiring write access.

d. It must support the DS-COV-B BIBB.

Although Gateways must meet DDC Hardware requirements , except for Niagara Framework Supervisory Gateways, they are not DDC Hardware and must not be used when DDC Hardware is required. (Niagara Framework Supervisory Gateways are both Gateways and DDC Hardware.)

2.1.3 Ethernet Switch

Ethernet Switches must be as specified in Section 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC

2.2 CONTROL NETWORK WIRING

a. BACnet MS/TP communications wiring must be in accordance with ASHRAE 135. The wiring must use shielded, three wire (twisted-pair with reference) cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors must be less than 30 pF per foot.

b. Building Control Network Backbone IP Network must use Ethernet media. Ethernet cables must be CAT-5e at a minimum and meet all requirements of IEEE 802.3 .

2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE

2.3.1 General Requirements

All DDC Hardware must meet the following requirements:

a. It must be locally powered and must incorporate a light to indicate the device is receiving power.

b. It must conform to the BTL Guide

c. It must be BACnet Testing Laboratory (BTL) Listed.

d. The Manufacturer's Product Data submittal for each piece of DDC Hardware must include the Protocol Implementation Conformance Statement (PICS) for that hardware as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

e. It must communicate and be interoperable in accordance with ASHRAE 135 and have connections for BACnet IP or MS/TP control network wiring.

f. Other than devices controlling terminal units or functioning solely as a BACnet Router, it must support DS-COV-B, DS-RPM-A and DS-RPM-B BIBBs.

g. Devices supporting the DS-RP-A BIBB must also support the DS-COV-A BIBB.

h. Application programs, configuration settings and communication information must be stored in a manner such that they persist through loss of power:

(1) Application programs must persist regardless of the length of time power is lost.

(2) Configured settings must persist for any loss of power less than 2,500 hours.

(3) Communication information, including but not limited to COV subscriptions, event reporting destinations, Notification Class Object settings, and internal communication settings, must persist for any loss of power less than 2,500 hours.

i. Internal Clocks:

(1) Clocks in DDC Hardware incorporating a Clock must continue to function for 120 hours upon loss of power to the DDC Hardware.

(2) DDC Hardware incorporating a Clock must support the DM-TS-B or DM-UTC-B BIBB.

j. It must have all functionality indicated and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to providing Objects or Niagara Framework Points as specified and as indicated on the Points Schedule.

k. In addition to these general requirements and the DDC Hardware Input-Output (I/O) Function requirements, all DDC Hardware must also meet any additional requirements for the application in which it is used (e.g. scheduling, alarming, trending, etc.).

l. It must meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.

m. Except for Niagara Framework Supervisory Gateways, Device must support Commandable Objects to support Override requirements as detailed in PART 3 EXECUTION

n. User interfaces which allow for modification of Properties or settings must be password-protected.

o. Devices communicating BACnet MS/TP must meet the following requirements:

(1) Must have a configurable Max_Master Property.

(2) DDC Hardware other than hardware controlling a single terminal unit must have a configurable Max_Info_Frames Property.

(3) Must respond to any valid request within 50 msec with either the appropriate response or with a response of "Reply Postponed".

(4) Must use twisted pair with reference and shield (3-wire media) wiring, or twisted pair with shield (2-wire media) wiring and use half-wave rectification.

p. Devices communicating BACnet/IP must use UDP Port 0xBAC0. Devices with configurable UDP Ports must default to 0xBAC0.

q. All Device IDs, Network Numbers, and BACnet MAC addresses of devices must be fully configurable without limitation, except MS/TP MAC addresses may be limited by ASHRAE 135 requirements.

r. Except for Niagara Framework Supervisory Gateways, DDC Hardware controlling a single terminal unit must have:

(1) Objects (including the Device Object) with an Object Name Property of at least 8 characters in length.

(2) A configurable Device Object Name.

(3) A configurable Device Object Description Property at least 16 characters in length.

s. Except for Objects in either Niagara Framework Supervisory Gateways or DDC Hardware controlling a single terminal unit, all Objects (including Device Objects) must:

(1) Have a configurable Object Name Property of at least 12 characters in length.

(2) Have a configurable Object Description Property of at least 24 characters in length.

t. For programmable DDC Hardware, provide and license to the project site all programming software required to program the Hardware in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

u. For programmable DDC Hardware, provide copies of the installed application programs (all software that is not common to every controller of the same manufacturer and model) as source code compatible with the supplied programming software in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted application program must be the complete application necessary for controller to function as installed and be sufficient to allow replacement of the installed controller with another controller of the same type.

2.3.2 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions must meet the following requirements:

2.3.2.1 Analog Inputs

DC Hardware analog inputs (AIs) must be implemented using ASHRAE 135 Analog Input Objects and perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00. Signal conditioning including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

2.3.2.2 Analog Outputs

DDC Hardware analog outputs (AOs) must be implemented using ASHRAE 135 Analog Output Objects and perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. DDC Hardware with Hand-Off-Auto (H-O-A) switches for analog outputs must provide for overriding the output to 0 percent and to 100 percent

2.3.2.3 Binary Inputs

DDC Hardware binary inputs (BIs) must be implemented using ASHRAE 135 Binary Input Objects and accept contact closures and must ignore transients of less than 5 milli-second duration. Protection against a transient 50VAC must be provided.

2.3.2.4 Binary Outputs

DDC Hardware binary outputs (BOs) must be implemented using ASHRAE 135 Binary Output Objects and provide relay contact closures or triac outputs for momentary and maintained operation of output devices. DDC Hardware with H-O-A switches for binary outputs must provide for overriding the output open or closed.

2.3.2.4.1 Relay Contact Closures

Closures must have a minimum duration of 0.1 second. Relays must provide at least 180V of isolation. Electromagnetic interference suppression must be provided on all output lines to limit transients to 50 Vac. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.2.4.2 Triac Outputs

Triac outputs must provide at least 180 V of isolation. Minimum contact rating must be 0.5 amperes at 24 Vac.

2.3.2.5 Pulse Accumulator

DDC Hardware pulse accumulators must be implemented using either an ASHRAE 135 Accumulator Object or an ASHRAE 135 Analog Value Object where the Present_Value is the totalized pulse count. Pulse accumulators must accept contact closures, ignore transients less than 5 msec duration, protect against
transients of 50 VAC, and accept rates of at least 20 pulses per second.

2.3.2.6 ASHRAE 135 Objects for Hardware Inputs and Outputs

The requirements for use of ASHRAE 135 objects for hardware input and outputs includes devices where the hardware sensor or actuator is integral to the controller (e.g. a VAV box with integral damper actuator, a smart sensor, a VFD, etc.)

2.3.3 Expansion Modules and Tethered Hardware

A single piece of DDC Hardware may consist of a base unit and also:

a. An unlimited number of hardware expansion modules, where the individual hardware expansion modules are designed to directly connect, both mechanically and electrically, to the base unit hardware. The expansion modules must be commercially available as an optional add-on to the base unit.

b. A single piece of hardware connected (tethered) to a base unit by a single cable where the cable carries a proprietary protocol between the base unit and tethered hardware. The tethered hardware must not contain control logic and be commercially available as an optional add-on to the base unit as a single package.

Note that this restriction on tethered hardware does not apply to sensors or actuators using standard binary or analog signals (not a communications protocol); sensors or actuators using standard binary or analog signals are not considered part of the DDC Hardware.

Hardware capable of being installed stand-alone, or without a separate base unit, is DDC Hardware and must not be used as expansion modules or tethered hardware.

2.3.4 Supervisory Control Requirements

2.3.4.1 Alarm Generation Hardware

Non-Niagara Framework DDC Hardware used for alarm generation must meet the following requirements:

a. Device must support the AE-N-I-B BIBB

b. The Recipient_List Property must be Writable for all Notification Class Objects used for alarm generation.

c. For all Objects implementing Intrinsic Alarming, the following Properties must be Writable:

(1) Time_Delay
(2) High_Limit
(3) Low_Limit
(4) Deadband
(5) Event_Enable
(6) If the issue date of this project specification is after 1 January 2016, Time_Delay_Normal must be writable.

d. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects.

2.3.5 Niagara Framework Supervisory Gateway

Any device implementing the Niagara Framework is a Niagara Framework Supervisory Gateway and must meet these requirements. In addition to the general requirements for all DDC Hardware, Niagara Framework Supervisory Gateway Hardware must:

a. Be direct digital control hardware matching all salient features of the JACE-9000.

b. Have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.

c. Manage communications between a field control network and the Niagara Framework Monitoring and Control Software, and between itself and other Niagara Framework Supervisory Gateways. Niagara Framework Supervisory Gateway Hardware must use Fox protocol for communication with other Niagara Framework Components, regardless of the manufacturer of the other components.

d. Be fully programmable using the Niagara Framework Engineering Tool and must support the following:

(1) Time synchronization, Calendar, and Scheduling using Niagara Scheduling Objects

(2) Alarm generation and routing using the Niagara Alarm Service

(3) Trending using the Niagara History Service and Niagara Trend Log Objects

(4) Integration of field control networks using the Niagara Framework Engineering Tool

(5) Configuration of integrated field control system using the Niagara Framework Engineering Tool when supported by the field control system

e. Meet the following minimum hardware requirements:

(1) One 10/100 Mbps Ethernet Port

(2) One or more MS/TP ports.

f. Provide access to field control network data and supervisory functions via web interface and support a minimum of 16 simultaneous users. Note: implementation of this capability may not be required on all projects.

g. Submit a backup of each Niagara Framework Supervisory Gateway as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The backup must be sufficient to restore a Niagara Framework Supervisory Gateway to the final as-built condition such that a new Niagara Framework Supervisory Gateway loaded with the backup is indistinguishable in functionality from the original.

2.4 NIAGARA FRAMEWORK ENGINEERING TOOL

The Niagara Framework Engineering Tool must be Niagara Workbench or an equivalent Niagara Framework engineering tool software must:

a. Have an unrestricted interoperability license and its Niagara Compatibility Statement (NiCS) must follow the Tridium Open NiCS Specification.

b. Be capable of performing network configuration for Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

c. Be capable of programming and configuring of Niagara Framework Supervisory Gateways and Niagara Framework Monitoring and Control Software.

d. Be capable of discovery of Niagara Framework Supervisory Gateways and all points mapped into each Niagara Framework Supervisory Gateway and making these points accessible to Niagara Framework Monitoring and Control Software.

Monitoring and Control Software is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION.

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION3.1.1 Niagara Framework Engineering Tool

Provide a Niagara Framework Engineering Tool.

3.1.2 Building Control Network (BCN)

Install the Building Control Network (BCN) as a single BACnet Internetwork consisting of a single IP network as the BCN Backbone and zero or more BACnet MS/TP networks. Note that in some cases there may only be a single device on the BCN Backbone.

Except for the IP Network and as permitted for the non-BACnet side of Gateways, use exclusively ASHRAE 135 networks.

3.1.2.1 Building Control Network IP Backbone

Install IP Network Cabling in conduit. Install Ethernet Switches in lockable enclosures. Install the Building Control Network (BCN) IP Backbone such that it is available at the Facility Point of Connection (FPOC) location in the Communications Room. When the FPOC location is a room number, provide sufficient additional media to ensure that the Building Control Network (BCN) IP Backbone can be extended to any location in the room.

Use UDP port 0xBAC0 for all BACnet traffic on the IP network. (Note that in a Niagara Framework system there may not be BACnet traffic on the IP Network)

3.1.2.2 BACnet MS/TP Networks

When using MS/TP, provide MS/TP networks in accordance with ASHRAE 135 and in accordance with the ASHRAE 135 figure "Mixed Devices on 3-Conductor Cable with Shield" (Figure 9-1.4 in the 2020 version of ASHRAE 135). Ground the shield at the BACnet Router and at no other point. Ground the reference wire at the BACnet Router through a 100 ohm resistor and do not ground it at any other point. In addition:

a. Provide each segment in a doubly terminated bus topology in accordance with TIA-485.

b. Provide each segment with 2 sets of network bias resistors in accordance with ASHRAE 135, with one set of resistors at each end of the MS/TP network.

c. Use 3 wire (twisted pair and reference) with shield media for all MS/TP media installed inside. Use fiber optic isolation in accordance with ASHRAE 135 for all MS/TP media installed outside buildings, or between multiple buildings.

d. For 18 AWG cable, use segments with a maximum length of 4000 ft. When using greater distances or different wire gauges comply with the electrical specifications of TIA-485.

e. For each controller that does not use the reference wire provide

transient suppression at the network connection of the controller if the controller itself does not incorporate transient suppression.

f. Install no more than 32 devices on each MS/TP segment. Do not use MS/TP to MS/TP routers.

g. Connect each MS/TP network to the BCN backbone via a Niagara Framework Supervisory Gateway configured as a BACnet Router.

h. For BACnet Routers, configure the MS/TP MAC address to 0. Assign MAC Addresses to other devices consecutively beginning at 1, with no gaps.

i. Configure the Max_Master Property of all devices to be 31.

3.1.2.3 Building Control Network (BCN) Installation

Provide a building control network meeting the following requirements:

a. Install all DDC Hardware connected to the Building Control Network.

b. Where multiple pieces of DDC Hardware are used to execute one sequence, install all DDC Hardware executing that sequence on a single MS/TP network dedicated to that sequence.

c. Traffic between BACnet networks must be exclusively via BACnet routers.

d. Use the Fox protocol for all traffic both originating and terminating at Niagara Framework components. Use the Fox protocol for all traffic originating or terminating at a Niagara Framework UMCS (including traffic to or from a future UMCS). All other traffic, including traffic between ASHRAE 135 devices and traffic between Niagara Framework Supervisory Gateways and ASHRAE 135 devices must be in accordance with ASHRAE 135.

3.1.3 DDC Hardware

Install all DDC Hardware that connects to an IP network in lockable enclosure. Install other DDC Hardware that is not in suspended ceilings in lockable enclosures. For all DDC hardware with a user interface, coordinate with site to determine proper passwords and configure passwords into device.

a. Except for zone sensors (thermostats), install all Tethered Hardware within 6 feet of its base unit.

b. Install and configure all BTL-Listed devices in a manner consistent with their BTL Listing such that the device as provided still meets all requirements necessary for its BTL Listing.

c. Install and configure all BTL-Listed devices in a manner consistent with the BTL Device Implementation Guidelines such that the device as provided meets all those Guidelines.

3.1.3.1 Device Identifiers, Network Addresses, and IP addresses

a. Do not use any Device Identifier or Network Number already used by another BACnet system at the project site. Coordinate Device IDs and Network Numbers with the installation through the COR. .

b. Coordinate device IP addresses with installation..

3.1.3.2 ASHRAE 135 Object Name Property and Object Description Property

Configure the Object_Names and Object_Descriptions properties of all ASHRAE 135 Objects (including Device Objects) as indicated on the Points Schedule (Point Name and Point Description) and as specified. At a minimum:

a. Except for DDC Hardware controlling a single terminal unit, configure the Object_Name and Object_Description properties of all Objects (including Device Objects) as indicated on the Points Schedule and as specified.

b. In DDC Hardware controlling a single terminal unit, configure the Device Object_Name and Device Object_Description as indicated on the Points Schedule and as specified.

When Points Schedule entries exceed the length limitations in the device, notify the COR and provide recommended alternatives for approval.

3.1.3.3 Niagara Framework Point Names and Descriptions

Configure the names and descriptions of all Points in Niagara Framework Supervisory Gateways as indicated on the Points Schedule and as specified.

3.1.3.4 Niagara Station IDs

Ensure that Niagara Station IDs of new Niagara Framework Supervisory Gateways are maintained as unique within UMCS front-end, including ensuring they do not conflict with any existing Niagara Station ID.

3.1.3.5 MS/TP Slave Devices

Configure all MS/TP devices as Master devices. Do not configure any devices to act as slave devices.

3.1.3.6 Change of Value (COV) and Read Property

a. To the greatest extent possible, configure all devices to support the SubscribeCOV service (the DS-COV-B BIBB). At a minimum, all devices supporting the DS-RP-B BIBB, other than devices controlling only a single terminal unit, must be configured to support the DS-COV-B BIBB.

b. Whenever supported by the server side, configure client devices to use the DS-COV-A BIBB.

3.1.3.7 Engineering Units

Configure devices to use English (Inch-Pound) engineering units as follows:

a. Temperature in degrees F

b. Air or natural gas flows in cubic feet per minute (CFM)

c. Water in gallons per minute (GPM)

d. Steam flow in pounds per hour (pph)

e. Differential Air pressures in inches of water column (IWC)

f. Water, steam, and natural gas pressures in PSI

g. Enthalpy in BTU/lb

h. Heating and cooling energy in MBTU (1MBTU = 1,000,000 BTU))

i. Cooling load in tons (1 ton = 12,000 BTU/hour)

j. Heating load in MBTU/hour (1MBTU = 1,000,000 BTU)

k. Electrical Power: kilowatts (kW)

l. Electrical Energy: kilowatt-hours (kWh)

3.1.3.8 Occupancy Modes

Use the following correspondence between value and occupancy mode whenever an occupancy state or value is required:

a. OCCUPIED mode: a value of one
b. UNOCCUPIED mode: a value of two
c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: a value of three

Note that elsewhere in this Section the Schedule Object is required to also support a value of four, which is reserved for future use. Also note that the behavior of a system in each of these occupancy modes is indicated in the sequence of operation for the system.

3.1.3.9 Use of BACnet Objects

Except as specifically indicated for Niagara Framework Objects, Use only standard non-proprietary ASHRAE 135 Objects and services to accomplish the project scope of work as follows:

a. Use Analog Input or Analog Output Objects for all analog hardware I/O. Do not use Analog Value Object for analog hardware I/O) .

b. Use Binary Input or Binary Output Objects for all binary hardware I/O. Do not use Binary Value Objects for binary hardware I/O.

c. Use Analog Value Objects for analog setpoints.

d. Use Accumulator Objects or Analog Value Objects for pulse inputs.

e. For occupancy modes, use Multistate Value Objects and the correspondence between value and occupancy mode specified in paragraph OCCUPANCY MODES.

f. Use a combination of Niagara Framework Alarm Extensions and Alarm Services, Intrinsic Alarming, and Notification Class Objects for alarm generation.

g. For all other points shown on the Points Schedule as requiring an ASHRAE 135 Object, use the Object type shown on the Points Schedule or, if no Object Type is shown, use a standard Object appropriate to the point.

3.1.3.9.1 Niagara Framework Objects

Points in the Niagara Framework Supervisory Gateway, even if used in a sequence or are shown on the Points Schedule, are not required to be exposed as BACnet Objects unless they are required to be available on the network by another device or sequence of operation (i.e. there is some other reason they are needed).

Use a Niagara Framework Supervisory Gateway as specified for all scheduling and trending. Use a Niagara Framework Supervisory Gateway as specified for all alarming except for intrinsic alarming.

3.1.3.10 Use of Standard BACnet Services

Except as noted in this paragraph, for all DDC Hardware (including Niagara Frameworks Supervisory Gateways when communicating with non-Niagara Framework DDC Hardware) use Standard BACnet Services as defined in this specification (which excludes some ASHRAE 135 services) exclusively for application control functionality and communication.

DDC Hardware that cannot meet this requirement may use non-standard services provided they can provide identical functionality using Standard BACnet Services when communicating with BACnet devices from a different vendor. When implementing non-standard services, document all non-standard services in the DDC Hardware Schedule as specified and as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

3.1.3.11 Device Application Configuration

a. For every property, setting or value shown on the Points Schedule or otherwise indicated as Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

   (1) BACnet services (including proprietary services)

   (2) Hardware settings on the device

   (3) The Niagara Framework

b. For every property, setting or value in non-Niagara Framework Hardware shown on the Points Schedule or otherwise indicated as Operator Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

   (1) A Writable Property of a standard BACnet Object

   (2) A Property of a standard BACnet Object that is Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable.
   (3) Using some other method supported by a Niagara Framework Supervisory Gateway

c. Configure Niagara Framework Supervisory Gateways such that the property, setting or value is configurable from a Niagara Framework Front End.

d. For every property, setting or value in a Niagara Framework Supervisory Gateway which is shown on the Points Schedule or otherwise indicated as Operator Configurable, configure the value to be configurable from within the Niagara Framework such that it can be

configured from a system graphic page at a Niagara Framework Front End.

3.1.3.12 Niagara Framework Engineering Tool

Use the Niagara Framework Engineering Tool to fully discover the field control system and make all field control system information available to the Niagara Framework Supervisory Gateway. Ensure that all points on the points schedule are available to the front end via the Fox protocol.

3.1.4 Scheduling, Alarming, Trending, and Overrides

3.1.4.1 Alarm Configuration

Configure alarm generation and management as indicated on the Points Schedule and as specified. Configure alarm generation in Niagara Framework Supervisory Gateways using Niagara Framework Alarm Extensions and Alarm Services or in other DDC Hardware (not Niagara Framework Supervisory Gateways) using ASHRAE 135 Intrinsic Alarming. Configure alarm management and routing for all alarms, including those generated via intrinsic alarming in other devices, in the Niagara Framework Supervisory Gateway such that the alarms are able to be accessed from the Niagara Framework Front End.

Where Intrinsic Alarming is used, configure intrinsic alarming as specified in paragraph "Configuration of ASHRAE 135 Intrinsic Alarm Generation". Configure a Niagara Framework Supervisory Gateway to provide a means to configure the intrinsic alarm parameters such that the Intrinsic Alarm is configurable from the front end via the Niagara Framework.

3.1.4.2 Configuration of ASHRAE 135 Intrinsic Alarm Generation

Intrinsic alarm generation must meet the following requirements:

Configure alarm generation as indicated on the Points Schedule and as specified using Intrinsic Alarming in accordance with ASHRAE 135 or Algorithmic Alarming in accordance with ASHRAE 135. Alarm generation must meet the following requirements:

a. Send alarm events as Alarms (not Events).

b. Use the ConfirmedNotification Service for alarm events.

c. For alarm generation, support two priority levels for alarms: critical and non-critical. Configure the Priority of Notification Class Objects to use Priority 112 for critical and 224 for non-critical alarms.

d. Number of Notification Class Objects for Alarm Generation:

(1) If the device implements non-critical alarms, or if any Object in the device supports Intrinsic Alarms, then provide a single Notification Class Object specifically for (shared by) all non-critical alarms.

(2) If the device implements critical alarms, provide a single Notification Class Object specifically for (shared by) all critical alarms.

(3) If the device implements both critical and non-critical alarms, provide only critical Notification Class Objects to the front end.

(4) If the device controls equipment other than a single terminal unit, provide both Notification Class Objects (one for critical, one for non-critical) even if no alarm generation is required at time of installation.

e. For all intrinsic alarms configure the Limit_Enable Property to set both HighLimitEnable and LowLimitEnable to TRUE. If the specified alarm conditions are for a single-sided alarm (only High_Limit used or only Low_Limit used) assign a value to the unused limit such that the unused alarm condition will not occur.

f. For all objects supporting intrinsic alarming, even if no alarm generation is required during installation, configure the following Properties as follows:

(1) Notification_Class to point to the non-Critical Notification Class Object in that device.

(2) Limit_Enable to enable both the HighLimitEnable and LowLimitEnable

(3) Notify_Type to Alarm

g. Configure the Recipient_List Property of the Notification Class Object to point to the Niagara Framework Supervisory Gateway managing the alarm.

3.1.4.3 Trending

Perform all trending using a Niagara Framework Supervisory Gateway using Niagara Framework History Extensions and Niagara Framework History Service exclusively.

3.1.4.4 Overrides

Provide an override for each point shown on the Points Schedule as requiring an override. Use the Niagara Framework for all overrides to points in Niagara Framework Supervisory Gateways. For overrides to other points, provide an override to a point in a Niagara Framework Supervisory Gateway via the Niagara Framework where the Niagara Framework Supervisory Gateway overrides the other point as specified.

Unless otherwise approved, provide Commandable Objects to support all Overrides in non-Niagara Framework Supervisory Gateway DDC Hardware. With specific approval from the Contracting Officer, Overrides for points which are not hardware outputs and which are in DDC hardware controlling a single terminal unit may support overrides via an additional Object provided for the override. No other means of implementing Overrides may be used.

a. Where Commandable Objects are used, ensure that WriteProperty service requests with a Priority of 10 or less take precedence over the SEQUENCE VALUE and that WriteProperty service request with a priority of 11 or more have a lower precedence than the SEQUENCE VALUE.

b. For devices implementing overrides via additional Objects, provide Objects which are NOT Written to as part of the normal Sequence of Operations and are Writable when Out_Of_Service is TRUE and Out_Of_Service is Writable. Use this point as an Override of the normal value when Out_Of_Service is TRUE and the normal value otherwise. Note these Objects may be modified as part of the sequence via local processes, but must not be modified by local processes when Out_Of_Service is TRUE.

3.1.5 BACnet Gateways

The requirements in this paragraph do not themselves permit the installation of hardware not meeting the other requirements of this section. Except for proprietary systems specifically indicated in Section 23 09 00, all control hardware installed under this project must meet the requirements of this specification, including the control hardware providing the network interface for a package unit or split system specified under another section. Only use gateways to connect to pre-existing control devices, and to proprietary systems specifically permitted by Section 23 09 00.

3.1.5.1 General Gateway Requirements

Provide BACnet Gateways to connect non-BACnet control hardware in accordance with the following:

a. Configure gateways to map writable data points in the controlled equipment to Writable Properties of Standard Objects, or to Niagara Framework points, as indicated in the Points Schedule and as specified.

b. Configure gateway to map readable data points in the controlled equipment to Readable Properties of Standard Objects, or to Niagara Framework points, as indicated in the Points Schedule and as specified.

c. Configure gateway to support the DS-COV-B BIBB for all points mapped to BACnet Objects.

d. Do not use non-BACnet control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls. (Note: A Niagara Framework Supervisory Gateway is BACnet control hardware.)

e. Do not use non-BACnet control hardware for system scheduling functions.

f. Each gateway must communicate with and perform protocol translation for non-BACnet control hardware controlling one and only one package unit or a single non-BACnet system specifically permitted by Section 23 09 00.

g. Connect one network port on the gateway to the Building Control Backbone IP Network or to a BACnet MS/TP network and the other port to the single piece of controlled equipment or the non-BACnet system specifically permitted by Section 23 09 00..

h. For gateways to existing package units or simple split systems, non-BACnet network wiring connecting the gateway to the package unit must not exceed 10 feet in length and must connect to exactly two devices: the controlled equipment (packaged unit) or split system

interface and the gateway.

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 710 I-P	(2009) Performance Rating of Liquid-Line Driers
AHRI 720	(2002) Refrigerant Access Valves and Hose Connectors
AHRI 750 I-P	(2016) Performance Rating of Thermostatic Refrigerant Expansion Valves
AHRI 760 I-P	(2014) Performance Rating of Solenoid Valves for Use with Volatile Refrigerants
AHRI 1370 I-P	(2017) Performance Rating of Electronic Expansion Valves

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 17	(2022) Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.22	(2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B31.1	(2022) Power Piping
ASME B31.5	(2022) Refrigeration Piping and Heat Transfer Components

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS A5.31/A5.31M	(2012) Specification for Fluxes for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B32	(2020) Standard Specification for Solder Metal
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2020) Standard Specification for Seamless Copper Tube
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B280	(2020) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture,

Selection, Application, and Installation

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01 (2023; with Change 2, 2024) Structural Engineering

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Refrigerant Piping System

SD-03 Product Data

Refrigerant Piping System

Spare Parts

Refrigerant Piping Tests

Verification of Dimensions

SD-06 Test Reports

Refrigerant Piping Tests

SD-07 Certificates

Service Organization

SD-10 Operation and Maintenance Data

Maintenance; G, RO

Operation and Maintenance Manuals; G, RO

Demonstrations; G, RO

1.3 QUALITY ASSURANCE

1.3.1 Contract Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation is the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter.

1.5 MAINTENANCE

1.5.1 General

Submit Data Package 2 plus operation and maintenance data complying with the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

1.5.2 Extra Materials

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis in the data.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

a. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship and that have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

b. The 2 year use must include applications of equipment and materials under similar circumstances and of similar size. The 2 years' experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

c. Products must be supported by a service organization. System components must be environmentally suitable for the indicated locations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

d. Exposed equipment moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices.

Install safety devices so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

e. Provide the manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component. Highlight the data to show information such as, but not limited to, material, size, options, performance charts, and curves in adequate detail to demonstrate compliance with contract requirements. Include the manufacturer's recommended installation instructions and procedures in the data provided. Provide data for the following components as a minimum:

(1) Piping and Fittings
(2) Valves
(3) Piping Accessories
(4) Pipe Hangers, Inserts, and Supports

2.2 ELECTRICAL WORK

Electrical equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Field wiring must be in accordance with manufacturer's instructions.

2.3 REFRIGERANT PIPING SYSTEM

Provide refrigerant piping, valves, fittings, and accessories in accordance with ASHRAE 15 & 34 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories must be compatible with the fluids used and capable of withstanding the pressures and temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service must be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant. Submit drawings, at least 5 weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements. Drawings must consist of:

a. Piping layouts which identify all valves and fittings.

b. Plans and elevations which identify clearances required for maintenance and operation.

2.4 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

2.4.1 Copper Tubing

Provide copper tubing conforming to ASTM B280 annealed or hard drawn as required. Copper tubing must bear the product identification markings in accordance with ASTM B280, "ACR" must be present on copper tubing. Copper tubing must be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing must not be used in sizes larger than 1-3/8 inches. Joints must be brazed except that joints on lines 7/8 inchand smaller may be flared. Cast copper alloy fittings for flared copper tube must conform to ASME B16.26 and ASTM B62. Wrought copper and bronze solder-joint pressure fittings must conform to ASME B16.22 and ASTM B75/B75M. Joints and fittings for brazed joint must be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings are not allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to

threaded ends of valves and equipment.

2.4.2 Solder

Solder must conform to ASTM B32, grade Sb5, tin-antimony alloy for service pressures up to 150 psig. Solder flux must be liquid or paste form, non-corrosive and conform to ASTM B813.

2.4.3 Brazing Filler Metal

Filler metal must conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type FB3-A or Type FB3-C flux, except Type BCuP-3, BCuP-4, or BCuP-5 may be used for brazing copper-to-copper joints. BAlSi-4 with AWS Type FB1-A flux may be used when joining copper piping to aluminum components.

2.4.4 Brazing Flux

Brazing flux must conform to AWS A5.31/A5.31M, Type FB3-A or Type FB3-C when using Type BAg-5 filler metal. Type FB1-A is to be used with Type BAlSi-4 filler metal.

2.4.5 Press Fittings

Press fittings are not acceptable for use in refrigerant piping systems.

2.5 VALVES

Valves must be designed, manufactured, and tested specifically for refrigerant service. The valve material and all internal components must be compatible with the specific refrigerant and lubricant used. Valve bodies must be of brass, bronze, steel, or ductile iron construction. Valves 1 inch and smaller must have brazed or socket welded connections. Valves larger than 1 inch must have tongue-and-groove flanged end connections. Do not use threaded end connections, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts must be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere must be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow must be legibly and permanently indicated on the valve body. Control valve inlets must be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Purge, charge and receiver valves must be of manufacturer's standard configuration.

2.5.1 Refrigerant Stop Valves

Valve must be the globe or full-port ball type with a back-seating stem especially packed for refrigerant service. Valve packing must be replaceable under line pressure. Provide valve with a handwheel or wrench operator and a seal cap. Valve must be the straight or angle pattern design as indicated.

2.5.2 Check Valves

Valve must be the swing or lift type as required to provide positive shutoff at the differential pressure indicated. Valve must be provided with resilient seat.

2.5.3 Liquid Solenoid Valves

Provide valves that comply with AHRI 760 I-P and are suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves must be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions must be furnished. Provide solenoid coils that are moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves must have safe working pressure of 610 psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Valves must have an operating pressure differential suitable for the refrigerant used.

2.5.4 Expansion Valves

Provide valve conforming to AHRI 750 I-P and ASHRAE 17. Valve must be the diaphragm and spring-loaded type with internal or external equalizers, and bulb and capillary tubing. Provide valve with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 2 degrees F of saturated suction temperature at evaporator conditions. Bulb charge must be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Do not use gas limited liquid charged valves and other valve devices for limiting evaporator pressure without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves must have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. Provide an isolatable pressure gauge in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicted or for constant evaporator loads.

2.5.5 Electronic Expansion Valves

Valve must conform to AHRI 1370 I-P and ASHRAE 17. The valve must prevent the return of liquid to the compressor in the event of power loss or low superheat.

2.5.6 Safety Relief Valves

Valve must be the two-way type, unless indicated otherwise. Valve must bear the ASME code symbol. Valve capacity must be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve must be of an automatically reseating design after activation.

2.5.7 Evaporator Pressure Regulators, Direct-Acting

Valve must include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve must maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load must not exceed the pressure difference corresponding to a 2 degrees F change in saturated refrigerant temperature at evaporator operating suction temperature. Spring must be selected for indicated maximum allowable

suction pressure range.

2.5.8 Refrigerant Access Valves

Provide refrigerant access valves and hose connections in accordance with AHRI 720.

2.6 PIPING ACCESSORIES

2.6.1 Filter Driers

Driers must conform to AHRI 710 I-P. Sizes 5/8 inch and larger must be the full flow, replaceable core type. Sizes 1/2 inch and smaller must be the sealed type. Cores must be of suitable desiccant that will not plug, cake, dust, channel, or break down, and must remove water, acid, and foreign material from the refrigerant. Constructfilter driers so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure must be 1,500 psi.

2.6.2 Sight Glass and Liquid Level Indicator

2.6.2.1 Assembly and Components

Assembly must be pressure- and temperature-rated and constructed of materials suitable for the service. Glass must be borosilicate type. Ferrous components subject to condensation must be electro-galvanized.

2.6.2.2 Gauge Glass

Gauge glass must include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

2.6.2.3 Bull's-Eye and Inline Sight Glass Reflex Lens

Provide bull's-eye and inline sight glass reflex lens for dead-end liquid service. For pipe line mounting, provide two plain lenses in one body suitable for backlighted viewing.

2.6.2.4 Moisture Indicator

Indicator must be a self-reversible action, moisture reactive, color changing media. Indicator must be furnished with full-color-printing tag containing color, moisture, and temperature criteria. Unless otherwise indicated, the moisture indicator must be an integral part of each corresponding sight glass.

2.6.3 Vibration Dampeners

Dampeners must be of the all-metallic bellows and woven-wire type.

2.6.4 Flexible Pipe Connectors

Connector must be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly must be constructed with a safety factor of not less than 4 at300 degrees F. Unless otherwise indicated, the length of a flexible connector

must be as recommended by the manufacturer for the service intended.

2.6.5 Strainers

Strainers used in refrigerant service must have brass or cast-iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens must be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.6.6 Pipe Hangers, Inserts, and Supports

Provide pipe hangers, inserts, guides, and supports conforming to MSS SP-58.

2.6.7 Escutcheons

Escutcheons must be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.7 FABRICATION

2.7.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

2.7.2 Factory Applied Insulation

Factory installed insulation must be in accordance with ASHRAE 90.1 - IP. Refrigerant suction lines between the cooler and each compressor must be insulated with not less than 1/2 inch thick unicellular plastic foam. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Test material supplied by a manufacturer with a jacket as a composite material. Provide jackets, facings, and adhesives that have a flame spread index less than 25 and a smoke developed index less than 50 when tested in accordance with ASTM E84.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform a verification of dimensions in the field. Submit a letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found before performing any work.

3.2 INSTALLATION

Pipe and fitting installation must conform to the requirements of ASME B31.1. Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove by reaming, and permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

3.2.1 Directional Changes

Make changes in direction with fittings, except that bending of pipe 4 inches and smaller is permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

3.2.2 Functional Requirements

Install piping 1/2 inch/10 feet of pipe in the direction of flow to ensure adequate oil drainage. Properly cap or plug open ends of refrigerant lines or equipment during installation to keep moisture, dirt, or other foreign material out of the system. Piping must remain capped until installation. Equipment piping must be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements must fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

3.2.3 Fittings and End Connections

3.2.3.1 Threaded Connections

Make threaded connections with tapered threads and make tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Do not show more than three threads after the joint is made.

3.2.3.2 Brazed Connections

Perform brazing in accordance with AWS BRH, except as modified herein. During brazing, fill the pipe and fittings with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, clean both the outside of the tube and the inside of the fitting with a wire fitting brush until the entire joint surface is bright

and clean. Do not use brazing flux on copper-to-copper connections. Remove surplus brazing material at all joints. Make steel tubing joints in accordance with the manufacturer's recommendations. Paint joints in steel tubing with the same material as the baked-on coating within 8 hours after joints are made. Protect tubing against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Support piping prior to brazing and do not spring or force.

3.2.3.3 Flared Connections

When flared connections are used, use a suitable lubricant between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.2.4 Valves

3.2.4.1 General

Install refrigerant stop valves on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Install stop valves with stems horizontal unless otherwise indicated. Install ball valves must be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches must be external to thermal insulation. Safety switches must not be fitted with isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves must be provided at all points of systems where accumulated non-condensable gases would prevent proper system operation. Valves must be furnished to match line size, unless otherwise indicated or approved.

3.2.4.2 Expansion Valves

Install expansion valves with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 2-1/8 inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 2-1/8 inches. Fasten the bulb securely with two clamps. Insulate ehe bulb . Install the bulb in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing must be facing up.

3.2.5 Vibration Dampers

Provide vibration damper in the suction and discharge lines on spring mounted compressors. Install vibration dampers parallel with the shaft of the compressor and anchor firmly at the upstream end on the suction line and the downstream end in the discharge line.

3.2.6 Strainers

Provide strainers immediately ahead of solenoid valves and expansion devices. Strainers may be an integral part of an expansion valve.

3.2.7 Filter Dryer

Provide a liquid line filter dryer on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Size

dryers in accordance with the manufacturer's recommendations for the system in which it is installed. Install dryers such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Install dryers in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.2.8 Flexible Pipe Connectors

Install connectors perpendicular to line of motion being isolated. Fit piping for equipment with bidirectional motion with two flexible connectors, in perpendicular planes. Install reinforced elastomer flexible connectors in accordance with manufacturer's instructions. Provide piping guides and restraints related to flexible connectors as required.

3.2.9 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports must conform to MSS SP-58, except as modified herein. Do not use pipe hanger types 5, 12, and 26. Fabricate hangers used to support piping 2 inches and larger to permit adequate adjustment after erection while still supporting the load. Support piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, by variable spring hangers and supports or by constant support hangers.

3.2.9.1 Hangers

Do not use Type 3 on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.2.9.2 Inserts

Secure Type 18 inserts to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.2.9.3 C-Clamps

Torque Type 19 and 23 C-clamps in accordance with MSS SP-58 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.2.9.4 Angle Attachments

Furnish Type 20 attachments used on angles and channels with an added malleable-iron heel plate or adapter.

3.2.9.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, must be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Use Type 40 shields on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. Use a high-density insulation insert of cellular glass under the Type 40 shield for piping 2 inches and larger.

3.2.9.6 Horizontal Pipe Supports

Space horizontal pipe supports as specified in MSS SP-58 and install a support no more than 1 foot from the pipe fitting joint at each change in direction of the piping. Space pipe supports no more than 5 feet apart at valves.

3.2.9.7 Vertical Pipe Supports

Support vertical pipe at each floor, except at slab-on-grade, and at intervals of not more than 15 feet not more than 8 feet from end of risers, and at vent terminations.

3.2.9.8 Pipe Guides

Provide Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides where required to allow longitudinal pipe movement. Provide lateral restraints as required. Provide slide materials that are suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.2.9.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, usea Type 39 saddle. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.2.9.10 High Temperature Guides with Cradles

Where there are high system temperatures and welding to piping is not desirable, the Type 35 guide must include a pipe cradle, welded to the guide structure and strapped securely to the pipe. Separate the pipe from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

3.2.9.11 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, use a clip or clamp where each pipe crosses the base support member. Spacing of the base support members must not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.2.9.12 Seismic Requirements

Support and brace piping and attached valves to resist seismic loads as specified under UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 SEISMIC BRACING FOR HVAC . Provide structural steel required for reinforcement to properly support piping, headers, and equipment but not shown under this section. Specify material used for support under Section 05 12 00 STRUCTURAL STEEL.

3.2.9.13 Structural Attachments

Attachment to building structure concrete and masonry must be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors must be applied with a safety factor not less than 5. Do not attach supports to metal decking. Construct masonry anchors for overhead

applications of ferrous materials only. Provide structural steel brackets required to support piping, headers, and equipment, but not shown, under this section. Specify material used for support under Section 05 12 00 STRUCTURAL STEEL.

3.2.10 Pipe Alignment Guides

Provide pipe alignment guides where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.2.11 Pipe Anchors

Provide anchors wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Provide anchors consisting of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Install anchor braces in the most effective manner to secure the desired results using turnbuckles where required. Do not attach supports, anchors, or stays where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, immediately anchor these items adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Submit detailed drawings of pipe anchors for approval before installation.

3.2.12 Building Surface Penetrations

Do not install sleeves in structural members except where indicated or approved. Provide galvanized sheet metal sleeves in non-load bearing surfaces conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Provide uncoated carbon steel pipe sleeves in load bearing surfaces conforming to ASTM A53/A53M, Standard weight. Apply sealants to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Do not install sleeves in structural members.

3.2.12.1 General Service Areas

Extend each sleeve through its respective wall, floor, or roof, and cut flush with each surface. Provide pipes passing through concrete or masonry wall or concrete floors or roofs with pipe sleeves fitted into place at the time of construction. Provide sleeves that allow a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, seal the annular space between pipe and sleeve or between jacket over-insulation and sleeve in accordance with Section 07 92 00 JOINT SEALANTS.

3.2.12.2 Waterproof Penetrations

Install pipes passing through roof or floor waterproofing membrane through a 17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange. Form flashing sleeve, and extend skirt or flange greater than 8 inches from the pipe and set over the roof or floor membrane in a troweled coating of bituminous cement. Extend the flashing sleeve up the pipe a minimum of 2 inches above the roof or floor penetration. Seal the annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered

insulation as indicated. Seal penetrations by either one of the following methods.

3.2.12.2.1 Waterproofing Clamping Flange

Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Clamp waterproofing membrane into place and place sealant in the caulking recess.

3.2.12.2.2 Modular Mechanical Type Sealing Assembly

In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Provide seals consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Loosely assemble links with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tighten the bolt to cause the rubber sealing elements to expand and provide a watertight seal between the pipe/conduit and the sleeve. Size each seal assembly as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals must provide sleeves of the proper diameters.

3.2.12.3 Fire-Rated Penetrations

Seal penetration of fire-rated walls, partitions, and floors as specified in Section 07 84 00 FIRESTOPPING.

3.2.12.4 Escutcheons

Provide escutcheons for finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Where sleeves project slightly from floors, use special deep-type escutcheons. Secure escutcheon to pipe or pipe covering.

3.2.13 Access Panels

Provide access panels for all concealed valves, vents, controls, and items requiring inspection or maintenance. Provide access panels of sufficient size and locate so that the concealed items may be serviced and maintained or completely removed and replaced.

3.2.14 Field Applied Insulation

Field installed insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.3 CLEANING AND ADJUSTING

Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture,

contaminated refrigerant, or any foreign matter are considered contaminated systems. Restore contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, using currently approved refrigerant and refrigeration manufacturer's procedures. Restore contaminated systems at no additional cost to the Government as determined by the Contracting Officer. Do not use water in any procedure or test.

3.4 TRAINING COURSE

a. Submit a schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training. Conduct a training course for 2 members of the operating staff as designated by the Contracting Officer. The training period must consist of a total 2 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

b. Cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations in the field posted instructions..

c. Submit 2 complete copies of an operation manual in bound 8 1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. Include the manufacturer's name, model number, and parts list in the booklets. Include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features in the manuals.

d. Submit 2 complete copies of maintenance manual in bound 8 1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. Include piping layouts and simplified wiring and control diagrams of the system as installed in the manuals.

3.5 REFRIGERANT PIPING TESTS

After all components of the refrigerant system have been installed and connected, subject the entire refrigeration system to pneumatic, evacuation, and startup tests as described herein. Submit a schedule, at least 2 weeks prior to the start of related testing, for each test. Identify the proposed date, time, and location for each test. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test. Provide the services of a qualified technician, as required, to perform all tests and procedures indicated herein. Coordinate field tests with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit 2 copies of the tests report in bound 8 1/2 by 11 inch booklets documenting all phases of the tests performed. Include initial test summaries, all repairs/adjustments made, and the final test results in the report.

3.5.1 Preliminary Procedures

Prior to pneumatic testing, isolate equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged

or cause personnel injury by imposed test pressure, positive or negative, from the test pressure, or remove from the system. Remove safety relief valves and rupture discs that are not part of factory sealed systems, and cap or plug openings.

3.5.2 Pneumatic Test

Provide pressure control and excess pressure protection at the source of test pressure. Valves must be wide open, except those leading to the atmosphere. Test gas must be dry nitrogen, with minus 70 degree F dewpoint and less than 5 ppm oil. Apply test pressure in two stages before any refrigerant pipe is insulated or covered. In accordance with ASME B31.5, a preliminary test not to exceed 25 psi must be applied as a means of locating major leaks. Every joint being tested must be coated with a thick soap or color indicating solution. The second stage test pressure must be at least 110 percent of the design pressure, but cannot exceed 130 percent of the design pressure of any component in the system. For large systems that are not completely visible, the pressure in the system must be gradually increased to one-half of the test pressure after which the pressure must be increased in steps of one-tenth of the test pressure, until the required test pressure has been reached. The test pressure must be continuously maintained for at leas 24 hours, after which it can be reduced to the leak test pressure. A correction factor of 0.3 psi will be allowed for each degree F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. The leak test pressure must be the design pressure, or a pressure specified in the engineering design. To repair leaks, the joint must be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, re-melting, or back-welding/brazing are not acceptable. Following repair, the entire system must be retested using the pneumatic tests described above. Reassemble the entire system once the pneumatic tests are satisfactorily completed.

3.5.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, relieve the pressure and evacuate the entire system to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature must be higher than 35 degrees F. Do not evacuate no more than one system at one time by one vacuum pump. Once the desired vacuum has been reached, close the vacuum line and allow the system to stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, evacuate the system again down to 300 micrometers and let set for another 1 hour period. Do not charge the system until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure rises above 500 micrometers, continue to repeat the evacuation procedures until all residual moisture has been removed. During evacuation, record pressures by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

3.5.4 System Charging and Startup Test

Following satisfactory completion of the evacuation tests, charge the system with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system must operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. Test the entire system tested for leaks. Test

fluorocarbon systems with halide torch or electronic leak detectors.

3.5.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must be immediatelyisolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. The refrigerant must not be discharged into the atmosphere.

3.5.6 Contractor's Responsibility

At all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time will the allowable leak rate exceed the leak rates allowed in Section 608 of the Clean Air Act: 30 percent of the full charge per year for industrial refrigeration, 20 percent of the full charge per year for commercial refrigeration, and 10 percent of the full charge per year for comfort cooling. Any system leaks within the first year must be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

-- End of Section --

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SECTION 23 30 00

HVAC AIR DISTRIBUTION
05/20, CHG 1: 02/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 201	(2002; R 2011) Fans and Systems
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data
AMCA 500-D	(2018) Laboratory Methods of Testing Dampers for Rating

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2016) Ventilation for Acceptable Indoor Air Quality
ASHRAE 70	(2023) Method of Testing the Performance of Air Outlets and Inlets
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A13.1	(2020) Scheme for the Identification of

Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B766	(2023) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C553	(2013; R 2019) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM E2016	(2022) Standard Specification for Industrial Woven Wire Cloth

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350	(2017; Version 1.2) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 701	(2023; ERTA 1 2023) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition

SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168	(2017) Adhesive and Sealant Applications

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 181	(2013; Reprint Dec 2021) UL Standard for Safety Factory-Made Air Ducts and Air Connectors
UL 705	(2017; Reprint Aug 2022) UL Standard for Safety Power Ventilators
UL Bld Mat Dir	(updated continuously online) Building Materials Directory
UL Electrical Construction	(2012) Electrical Construction Equipment Directory

1.2 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

1.2.1 Mechanical Equipment Identification

The number of charts and diagrams must be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.2.1.1 Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

1.2.1.2 Diagrams

Submit proposed diagrams, at least 2 weeks prior to start of related testing. provide neat mechanical drawings provided with extruded aluminum frame under 1/8-inch glass or laminated plastic, system diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods

of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. After approval, post these items where directed.

1.2.2 Service Labeling

Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Provide labels in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Air handling unit Number	AHU -
Control and instrument air	CONTROL AND INSTR.
Exhaust Fan Number	EF -
VAV Box Number	VAV -
Fan Coil Unit Number	FC -
Terminal Box Number	TB -
Unit Ventilator Number	UV -

Identify similar services with different temperatures or pressures. Where pressures could exceed 125 pounds per square inch, gage, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:

a. Each point of entry and exit of pipe passing through walls.

b. Each change in direction, i.e., elbows, tees.

c. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

d. In long straight runs, locate labels at distances within eyesight of each other not to exceed 75 feet. All labels must be visible and legible from the primary service and operating area.

For Bare or Insulated Pipes	
for Outside Diameters of	Lettering
1/2 thru 1-3/8 inch	1/2 inch
1-1/2 thru 2-3/8 inch	3/4 inch

For Bare or Insulated Pipes	
for Outside Diameters of	Lettering
2-1/2 inch and larger	1-1/4 inch

1.2.3 Color Coding

Color coding of all piping systems must be in accordance with ASME A13.1 .

1.3 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G, DO

SD-03 Product Data

Insulated Nonmetallic Flexible Duct Runouts

Duct Connectors

Duct Access Doors

Manual Balancing Dampers

Diffusers

Registers and Grilles

Louvers

Air Vents, Penthouses, and Goosenecks

In-Line Centrifugal Fans

Axial Flow Fans; G, DO

Product data for Axial Flow Fans associated with the generator supply fans shall be submitted concurrent to the following Section 26 29 23 adjustable speed drives associated with "Generator Supply Fans." The review period for the items requiring concurrent submission shall not commence until the last of the required concurrent submittal items is received by the government.

Ceiling Exhaust Fans

Test Procedures

Diagrams; G, RO

SD-06 Test Reports

Performance Tests; G, RO

SD-07 Certificates

Bolts

Ozone Depleting Substances Technician Certification

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions

Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, RO

Manual Balancing Dampers

In-Line Centrifugal Fans

Axial Flow Fans; G, RO

Ceiling Exhaust Fans

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.

a. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.

b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.

c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

d. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or ENERGY STAR covered product categories, equipment selected must have as a minimum the efficiency rating identified under "Energy-Efficient Products" at http://femp.energy.gov/procurement.

1.4.1 Prevention of Corrosion

Protect metallic materials against corrosion. Provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Provide hot-dip galvanized ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials in accordance with ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 for interior locations. Provide written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. Include illustrations of product markings, and the number of each type of bolt to be furnished in the certification.

1.4.2 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.4.3 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

1.4.4 Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

1.4.5 Test Procedures

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Provide equipment items that are supported by a service organization. In product categories covered by ENERGY STAR or the Federal Energy Management Program, provide equipment that is listed on the ENERGY STAR Qualified Products List or that meets or exceeds the FEMP-designated Efficiency Requirements.

2.2 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Provide identification plates that are layers, black-white-black, engraved to show white letters on black background. Letters must be upper case. Identification plates that are 1-1/2-inches high and smaller must be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high must be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger must have beveled edges. Install identification plates using a compatible adhesive.

2.3 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard.

2.4 ELECTRICAL WORK

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00INTERIOR DISTRIBUTION SYSTEM. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Provide premium efficiency type integral size motors in accordance with NEMA MG 1.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system , and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload

protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

e. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controllers are allowed to accomplish the same function. Use solid-state variable-speed controllers for motors rated 10 hp or less and adjustable frequency drives for larger motors. Provide variable frequency drives for motors as specified in Section 26 29 23 ADJUSTABLE SPEED DRIVE SYSTEMS UNDER 600 VOLTS.

2.5 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts must not degrade the surrounding concrete.

2.6 SEISMIC ANCHORAGE

Anchor equipment in accordance with applicable seismic criteria for the area and as defined in SMACNA 1981

2.7 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.8 DUCT SYSTEMS

2.8.1 Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification .

b. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.

c. Provide ductwork that meets the requirements of Seal Class A. Provide ductwork in VAV systems upstream of the VAV boxes that meets the requirements of Seal Class A.

e. Provide sealants that conform to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant. Provide duct sealant products that meet either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168 (HVAC duct sealants are classified as "Other" within the SCAQMD Rule 1168 sealants table).

f. Make spiral lock seam duct, and flat oval with duct sealant and lock

with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not acceptable.

g. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

2.8.1.1 Insulated Nonmetallic Flexible Duct Runouts

Use flexible duct runouts only where indicated. Runout length is indicated on the drawings, and is not to exceed 5 feet. Provide runouts that are preinsulated, factory fabricated, and that comply with NFPA 90A and UL 181. Provide either field or factory applied vapor barrier. Provide not less than 20 ounce glass fabric duct connectors coated on both sides with neoprene. Where coil induction or high velocity units are supplied with vertical air inlets, use a streamlined, vaned and mitered elbow transition piece for connection to the flexible duct or hose. Provide a die-stamped elbow and not a flexible connector as the last elbow to these units other than the vertical air inlet type. Insulated flexible connectors are allowed as runouts. Provide insulated material and vapor barrier that conform to the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Do not expose the insulation material surface to the air stream.

2.8.1.2 General Service Duct Connectors

Provide a flexible duct connector approximately 6 inches in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardent fabrics" in UL Bld Mat Dir.

2.8.1.3 Aluminum Ducts

ASTM B209, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.8.2 Duct Access Doors

Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 15 by 18 inches, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.8.3 Manual Balancing Dampers

Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators. Install dampers that are 2 gauges heavier than the duct in which installed. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Provide stand-off mounting items that are integral with the operator or standard accessory of the damper manufacturer.

2.8.4 Air Supply And Exhaust Air Dampers

Provide outdoor air supply and exhaust air dampers that have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - IP, including maximum Damper Leakage for:

a. Climate Zones 1,2,6,7,8 the maximum damper leakage at 1.0 inch w.g. for motorized dampers is 4 cfm per square foot of damper area and non-motorized dampers are not allowed.

b. All other Climate Zones the maximum damper leakage at 1.0 inch w.g. is 10 cfm per square foot and for non-motorized dampers is 20 cfm per square foot of damper area.

Dampers smaller than 24 inches in either direction may have leakage of 40 cfm per square foot.

2.8.5 Air Deflectors (Volume Extractors) and Branch Connections

Provide air deflectors (volume extractors) at all duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections are allowed in lieu of deflectors for branch connections. Furnish all air deflectors (volume extractors), except those installed in 90 degree elbows, with an approved means of adjustment. Provide easily accessible means for adjustment inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, provide external adjustments with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Provide factory-fabricated air deflectors consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Provide factory or field assembled air deflectors (volume extractors). Make adjustment from the face of the diffuser or by position adjustment and lock external to the duct. Provide stand-off brackets on insulated ducts as described herein. Provide fixed air deflectors (volume extractors), also called turning vanes, in 90 degree elbows.

2.8.6 Diffusers, Registers, and Grilles

Provide factory-fabricated units of corrosion-resistant steel or aluminum that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified inlets and outlets according to ASHRAE 70. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Provide linear slot diffusers with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, protect them by a grille or screen according to NFPA 90A.

2.8.6.1 Diffusers

Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Provide air handling troffers or combination light and ceiling diffusers conforming to the requirements of UL Electrical Construction for the interchangeable use as cooled or heated air supply diffusers or return air units. Install ceiling mounted units with rims tight against ceiling. Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.

2.8.6.2 Registers and Grilles

Provide units that are four-way directional-control type, except provide return and exhaust registers that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 6 inches below the ceiling unless otherwise indicated. Locate return and exhaust registers 6 inches above the floor unless otherwise indicated. Achieve four-way directional control by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Provide grilles as specified for registers, without volume control damper.

2.8.7 Louvers

Provide louvers for installation in exterior walls that are associated with the air supply and distribution system as specified in Section 08 91 00 METAL WALL AND DOOR LOUVERS.

2.8.8 Air Vents, Penthouses, and Goosenecks

Fabricate air vents, penthouses, and goosenecks from galvanized steel or aluminum sheets with galvanized or aluminum structural shapes. Provide sheet metal thickness, reinforcement, and fabrication that conform to SMACNA 1966. Accurately fit and secure louver blades to frames. Fold or

bead edges of louver blades for rigidity and baffle these edges to exclude driving rain. Provide air vents, penthouses, and goosenecks with bird screen.

2.8.9 Bird Screens and Frames

Provide bird screens that conform to ASTM E2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

2.9 AIR SYSTEMS EQUIPMENT

2.9.1 Fans

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans must not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than 140 percent of the connected driving capacity. Provide variable pitch motor sheaves for 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

2.9.1.1 In-Line Centrifugal Fans

Provide in-line fans with centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Mount fans in a welded tubular casing. Provide a fan that axially flows the air in and out. Streamline inlets with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Enclose and isolate fan bearings and drive shafts from the air stream. Provide precision, self aligning ball or roller type fan bearings that are sealed against dust and dirt and are permanently lubricated. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide motors with dripproof enclosure. Provide magnetic motor starters across-the-line with enclosures as indicated.

2.9.1.2 Axial Flow Fans

Provide axial flow fans complete with drive components and belt guard, with steel housing, cast fan wheel, cast or welded steel diffusers, fan shaft, bearings, and mounting frame as a factory-assembled unit. Provide fan wheels that are dynamically balanced and keyed to the fan shaft, with radially projecting blades of airfoil cross-section. Enclose and isolate fan bearings and drive shafts from the air stream. Permanently lubricate fan bearings or provide them with accessible grease fittings. Provide precision self-aligning ball or roller type fan bearings that are sealed against dust and dirt. Provide fan bearings that have a L50 rated bearing life at not less than 200,000 hours of operation as defined by ABMA 9 and ABMA 11. Provide fan inlets with an aerodynamically shaped bell and an inlet cone. Install diffuser or straightening vanes at the fan discharge to minimize turbulence and provide smooth discharge air flow. Furnish fan unit with inlet and outlet flanges and inlet screen. Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have dripproof enclosure.

2.9.1.3 Ceiling Exhaust Fans

Provide centrifugal type, direct driven suspended cabinet-type ceiling exhaust fans. Provide fans with acoustically insulated housing. Provide chatter-proof backdraft damper. Provide egg-crate design or louver design integral face grille. Mount fan motors on vibration isolators. Furnish unit with mounting flange for hanging unit from above. Provide U.L. listed fans.

2.10 SUPPLEMENTAL COMPONENTS/SERVICES

2.10.1 Refrigerant Piping

The requirements for refrigerant piping are specified in Section 23 23 00 REFRIGERANT PIPING.

2.10.2 Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that generates condensate in accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE except as modified herein.

2.10.3 Backflow Preventers

The requirements for backflow preventers are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.10.4 Insulation

The requirements for shop and field applied insulation are specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.10.5 Controls

The requirements for controls are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

a. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of 3 feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices)and an additional 3 feet.

c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

3.2.1 Condensate Drain Lines

Provide water seals in the condensate drain from all units . Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.2 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.3 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced.

3.2.4 Flexible Duct

Install pre-insulated flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

3.2.5 Metal Ductwork

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

3.2.6 Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

3.2.7 Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts and plenums.

3.2.8 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.3 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 3-inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of 14 calendar days before being loaded.

3.4 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.5 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks.

3.6 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 15 inches and smaller. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.

3.6.1 Sleeves

Fabricate sleeves, except as otherwise specified or indicated, from 20 gauge thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A53/A53M, Schedule 20.

3.6.2 Framed Prepared Openings

Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

3.6.3 Insulation

Provide duct insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

3.6.4 Closure Collars

Provide closure collars of a minimum 4 inches wide, unless otherwise indicated, for exposed ducts and items on each side of penetrated surface, except where equipment is installed. Install collar tight against the surface and fit snugly around the duct or insulation. Grind sharp edges

smooth to prevent damage to penetrating surface. Fabricate collars for round ducts 15 inches in diameter or less from 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 4 fasteners where the opening is 12 inches in diameter or less, and a minimum of 8 fasteners where the opening is 20 inches in diameter or less.

3.6.5 Firestopping

Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 00 FIRESTOPPING.

3.7 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.8 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.9 PERFORMANCE TESTS

Conduct performance tests as required in Section 23 05 93 Testing, Adjusting and Balancing for HVAC and Section 23 09 00 Instrumentation and Control for HVAC.

3.10 CLEANING AND ADJUSTING

Thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans that are operated during construction, and provide new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Provide documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.11 OPERATION AND MAINTENANCE

3.11.1 Operation and Maintenance Manuals

Submit 2 manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

3.11.2 Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of 16 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --

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DECENTRALIZED UNITARY HVAC EQUIPMENT
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 340/360 I-P	(2015) Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
AHRI 540	(2015) Performance Rating Of Positive Displacement Refrigerant Compressors And Compressor Units
AHRI 700	(2016) Specifications for Fluorocarbon Refrigerants
ANSI/AHRI 210/240	(2008; Add 1 2011; Add 2 2012) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 460	(2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2013) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 15 & 34	(2013) ASHRAE Standard 34-2016 Safety Standard for Refrigeration Systems/ASHRAE Standard 34-2016 Designation and Safety Classification of Refrigerants-ASHRAE Standard 34-2016
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C1071	(2019) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-5541	(2006; Rev F) Chemical Conversion Coatings on Aluminum and Aluminum Alloys

UL SOLUTIONS (UL)

UL 207	(2022) UL Standard for Safety Refrigerant-Containing Components and Accessories, Nonelectrical
UL 1995	(2015; Reprint Aug 2022) UL Standard for Safety Heating and Cooling Equipment

1.2 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Spare Parts

Posted Instructions

System Performance Tests

Training

Inventory

Supplied ProductsG, DO

Manufacturer's Standard Catalog Data

SD-06 Test Reports

Refrigerant Tests, Charging, and Start-Up

System Performance Tests; G, RO

SD-07 Certificates

Service Organizations

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, RO

SD-11 Closeout Submittals

Ozone Depleting Substances

1.3 QUALITY ASSURANCE

Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets,

fittings, and accessories to meet such conditions. Submit drawings consisting of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

h. Equipment schedules

1.4 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Properly protect and care for all material both before and during installation. Submit an inventory of all the stored items. Replace any materials found to be damaged, at no additional cost to the Government. During installation, cap piping and similar openings capped to keep out dirt and other foreign matter.

1.5 WARRANTY

Provide equipment with the Manufacturer's Standard Warranty.

PART 2 PRODUCTS

2.1 ENERGY EFFICIENCY REQUIREMENTS

42 USC 8259b requires the procurement of energy efficient products in product categories covered by the Energy Star program or the Federal Energy Management Program for designated products. A list of covered product categories is available from the Federal Energy Management Web site at http://energy.gov/eere/femp/covered-product-categories. A list of qualified light commercial products is available at http://www.energystar.gov/productfinder/product/certified-light-commercial-hvac/result

Submit Material, Equipment, and Fixtures List of all supplied products within a covered product category, including manufacturer's catalog numbers, specification and drawing reference number, warranty information, fabrication site, and energy performance data. For product categories covered by the Energy Star program, submit documentation that the product is Energy Star-qualified. For product categories covered by the Federal Energy Management Program, submit documentation that the product meets or

exceeds FEMP-designated efficiency requirements.

2.1.1 Air-Source Heat Pumps

Selected air-source heat pumps are required to meet applicable performance requirements specified by Energy Star. Information on the requirements can be found for residential models (single-phase units of 65,000 BTU/h or less)at http://www.energystar.gov/products/specs/system/files/Central_ASHP_and_CAC_Program_Req v4_1.pdf and for light commercial models (three-phase units of less than 240,000 BTU/h) at http://www.energystar.gov/products/specs/system/files/lchvac_prog_req_v2_2_0.pdf.

2.2 MATERIALS

Provide Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data includes manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Submit data for each specified component. Minimum efficiency requirements must be in accordance with ASHRAE 90.1 - IP.

2.2.1 Standard Products

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening . The 2 year use includes applications of equipment and materials under similar circumstances and of similar size. The 2 years' experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products must be supported by a service organization. Ensure system components are environmentally suitable for the indicated geographic locations.

2.2.2 Product Sustainability Criteria

2.2.2.1 Energy Efficient Equipment

Provide equipment meeting the efficiency requirements as stated within this section.

2.2.2.2 Electrical Equipment / Motors

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical motor driven equipment specified must be provided complete with motors, motor starters, and controls. Electrical characteristics must be

as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, must be the premium efficiency type in accordance with NEMA MG 1. Field wiring must be in accordance with manufacturer's instructions. Each motor must conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors must be continuous duty with the enclosure specified. Motor starters must be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors must be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors must be sized for the applicable loads. Motor torque must be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings must be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided.

2.2.2.3 Ozone Depleting Substances

Unitary air conditioning equipment must not use CFC-based refrigerants. Refrigerant may be an approved alternative refrigerant in accordance with EPA's Significant New Alternative Policy (SNAP) listing.

2.2.3 Nameplates

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors must have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates must be durable and legible throughout equipment life and made of anodized aluminum . Fix plates in prominent locations with nonferrous screws or bolts.

2.2.4 Safety Devices

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

2.3 EQUIPMENT

2.3.1 Split-System Heat Pumps

2.3.1.1 Small-Capacity Split-System Air-Conditioners (Not Exceeding 65,000 Btu/hr)

Provide an air-cooled, split system which employs a remote condensing unit, a separate wall mounted indoor unit, and interconnecting refrigerant piping. Provide the heat pump type unit conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with ANSI/AHRI 210/240. Provide indoor unit with necessary fans, air filters, and galvanized steel cabinet construction.

The remote unit must be as specified in paragraph CONDENSING UNIT. Provide double-width, double inlet, forward curved backward inclined, or airfoil blade, centrifugal scroll type evaporator or supply fans. Provide the manufacturer's standard condenser or outdoor fans for the unit specified.

2.3.1.1.1 Energy Efficiency

Provide unit with an Energy Star label or ensure the unit meets the FEMP energy efficiency values for the project type.

2.3.1.1.2 Air-to-Refrigerant Coil

Provide condensing coils with copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil testing and prior to evaluation and charging.

2.3.1.1.3 Refrigeration Circuit

Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide refrigerant charging valves. Provide filter-drier in liquid line to prevent freeze-up in event of loss of water flow during heating cycle.

2.3.1.1.4 Unit Controls

Provide unit internally prewired with a 24 volt control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Internally protect unit by fuses or a circuit breaker in accordance with UL 1995. Equip units with three-phase power with phase monitoring protection to protect against problems caused by phase loss, phase imbalance and phase reversal. Provide unit with manufacturers standard programmable electronic thermostat.

Controls must include a control system interface to a BACnet Control system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.3.1.1.5 Condensing Coil

Provide coils with copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Provide galvanized steel or aluminum casing. Avoid contact of dissimilar metals. Test coils in accordance with ANSI/ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal eacj coil after testing and prior to evaluation and charging. Provide separate expansion devices for each compressor circuit.

2.3.1.1.6 Remote Condenser or Condensing Unit

Fit each remote condenser coil fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 120 degrees F at 104 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of 0degrees F. Provide fan and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES.

2.3.1.1.7 Air Filters

Provide manufacturers standard filter for product supplied.

2.3.1.1.8 Fans

Provide direct driven, statically and dynamically balanced, centrifugal type fans. Design the outdoor fan so that condensate will evaporate without drip, splash, or spray on building exterior. Provide indoor fan with a minimum two-speed motor with built-in overload protection. Fan motors must be the inherently protected, permanent split-capacitor type.

2.3.1.2 Large-Capacity Split-System Air Conditioners (Greater Than 65,000 Btu/h)

Provide an air-cooled, split system which employs a remote condensing unit, a separate ceiling mounted indoor unit, and interconnecting refrigerant piping. Provide the heat pump type unit conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit must be rated in accordance with AHRI 340/360 I-P. Provide unit with necessary fans, air filters, and cabinet construction as specified in paragraph UNITARY EQUIPMENT ACCESSORIES. Provide the manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type condenser or outdoor fans.

2.3.1.2.1 Air-To-Refrigerant Coil

Provide coils with copper or aluminum tubes tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Provide casing of galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil testing and prior to evaluation and charging. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge with refrigerant and oil. Provide separate expansion devices for each compressor circuit.

2.3.1.2.2 Compressor

Provide direct drive, semi-hermetic or hermetic reciprocating, or scroll type compressor capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading

capabilities, in which case the compressors operate in sequence, and each compressor has an independent refrigeration circuit through the condenser and evaporator. Start compressors in the unloaded position. Provide each compressor with vibration isolators, crankcase heater, thermal overloads, high and low pressure safety cutoffs and protection against short cycling.

2.3.1.2.3 Refrigeration Circuit

Refrigerant-containing components must comply with ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant charging valves and connections, and pumpdown valves for each circuit.

2.3.1.2.4 Unit Controls

Provide unit internally prewired with a 24 volt control circuit powered by an internal transformer. Provide terminal blocks for power wiring and external control wiring. Unit must have cutoffs for high and low pressure, and low oil pressure for compressors with positive displacement oil pumps, supply fan failure, and safety interlocks on all service panels. Head pressure controls must sustain unit operation with ambient temperature of 0degrees F. Adjustable-cycle timers must prevent short-cycling. Stage multiple compressors by means of a time delay. Internally protect unit by fuses or a circuit breaker in accordance with UL 1995.

Controls must include a control system interface to a BACnet Control system. The control system interface, as well as any network between physically separate units, must meet the requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

2.3.1.2.5 Remote Condenser or Condensing Unit

Fit each remote condenser coil with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature must not exceed 120 degrees F at 95 degrees F ambient. Provide unit with low ambient condenser controls to ensure proper operation in an ambient temperature of 0 degrees F. Provide fan and cabinet construction must be provided as specified in paragraph UNITARY EQUIPMENT COMPONENTS.

2.3.1.2.5.1 Air-Cooled Condenser

Provide unit rated in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Provide factory fabricated, tested, packaged, and self-contained unit. Unit must be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

a. Provide interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit as required and as indicated. Provide electrical and refrigeration piping terminal connections between condensing unit and evaporator units.

c. Coils must have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Casing must be galvanized steel or aluminum. Avoid contact of dissimilar metals. Test coils in accordance with ASHRAE 15 & 34 at the factory and ensure suitability for the working pressure of the installed system. Dehydrate and seal each coil after testing and prior to evaluation and charging. Provide each unit with a factory operating charge of refrigerant and oil or a holding charge. Field charge unit shipped with a holding charge. Provide separate expansion devices for each compressor circuit.

d. Provide a complete control system with required accessories for regulating condenser pressure by fan cycling, solid-state variable fan speed, modulating condenser coil or fan dampers, flooding the condenser, or a combination of the above. Construct unit mounted control panels or enclosures in accordance with applicable requirements of NFPA 70 and house in NEMA ICS 6, Class 1 or 3A enclosures. Controls must include control transformer, fan motor starters, solid-state speed control, overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.3.1.2.5.2 Compressor

Provide compressor rated in accordance with AHRI 540. Provide direct drive, semi-hermetic or hermetic reciprocating, or scroll type compressor capable of operating at partial load conditions. Compressor must be capable of continuous operation down to the lowest step of unloading as specified. Provide units 120,000 Btuh and larger with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors operate in sequence, and each compressor must have an independent refrigeration circuit through the condenser and evaporator. Each compressor must start in the unloaded position. Provide each compressor with vibration isolators, crankcase heater, thermal overloads, and high and low pressure safety cutoffs and protection against short cycling.

2.3.1.2.5.3 Fans

Provide fan wheel shafts supported by either maintenance-accessible grease lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Mount fan motor and fan assembly on a common base to allow consistent belt tension with no relative motion between fan and motor shafts. The entire fan motor and fan assembly must be completely vibrationally isolated from the unit. Select unit fans to produce the cfm required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type. Provide automatic-reset type thermal overload protection. Construct fan wheels of aluminum or galvanized steel. Provide centrifugal fan wheel housings of galvanized steel, and construct centrifugal fan casings of aluminum or galvanized steel. Steel elements of fans, except fan shafts, must be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Recoat mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting with an approved zinc-rich compound. Statically and dynamically balance fan wheels or propellers. Condenser fans must be propeller type, direct drive, statically balanced with galvanized steel blades and permanently lubricated ball bearings. Protect

condenser fan motor drive bearings with water slingers or shields. Fit all belt drives with guards where exposed to contact by personnel.

2.3.1.2.6 Filters

Provide manufacturers standard filter for product supplied.

2.4 COMPONENTS

2.4.1 Refrigerant and Oil

Refrigerant must be one of the fluorocarbon gases. Refrigerants must have number designations and safety classifications in accordance with ASHRAE 15 & 34. Refrigerants must meet the requirements of AHRI 700 as a minimum. Provide a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil must be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge must be in accordance with manufacturer's recommendation.

2.4.2 Fans

Fan wheel shafts must be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans must be selected to produce the cfm required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type. Thermal overload protection must be of the manual or automatic-reset type. Fan wheels or propellers must be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings must be of galvanized steel, and both centrifugal and propeller fan casings must be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, must be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting must be recoated with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Direct-drive fan motors must be of the multiple-speed variety.

2.4.3 Coil Frost Protection

Provide each circuit with a manufacturer's standard coil frost protection system. The coil frost protection system must use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Use timers to prevent the compressor from rapid cycling.

2.4.4 Pressure Vessels

Pressure vessels must conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, test pressure components at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces must be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.4.4.1 Liquid Receiver

A liquid receiver must be provided when a system's condenser or compressor does not contain a refrigerant storage capacity of at least 20 percent in excess of a fully charged system. Receiver must be designed, filled, and

rated in accordance with the recommendations of ANSI/AHRI 495, except as modified herein. Receiver must be fitted to include an inlet connection; an outlet drop pipe with oil seal and oil drain where necessary; two bull's-eye liquid level sight glass in same vertical plane, 90 degrees apart and perpendicular to axis of receiver or external gauge glass with metal guard and automatic stop valves; and purge, charge, equalizing, pressurizing, plugged drain and service valves on the inlet and outlet connections. Receiver must be provided with a relief valve of capacity and setting in accordance with ASHRAE 15 & 34.

2.4.4.2 Oil Separator

Separator must be the high efficiency type and be provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Pressure drop through a separator must not exceed 10 psi during the removal of hot gas entrained oil. Connections to compressor must be as recommended by the compressor manufacturer. Separator must be provided with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass, and strainer.

2.4.4.3 Oil Reservoir

Reservoir capacity must equal one charge of all connected compressors. Reservoir must be provided with an external liquid gauge glass, plugged drain, and isolation valves. Vent piping between the reservoir and the suction header must be provided with a 5 psi pressure differential relief valve. Reservoir must be provided with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.4.5 Cabinet Construction

Casings for the specified unitary equipment must be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces must be 18 gauge galvanized steel or 0.071 inch thick aluminum on units with a capacity above 20 tons and 20 gauge galvanized steel or 0.064 inch thick aluminum on units with a capacity less than 20 tons. Casing must be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness must be 20 gauge. Provisions to permit replacement of major unit components must be incorporated. Penetrations of cabinet surfaces, including the floor, must be sealed. Unit must be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan must be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation must be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces must prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation must conform to ASTM C1071. Paint and finishes must comply with the requirements specified in paragraph FACTORY COATING.

2.4.5.1 Indoor Cabinet

Indoor cabinets must be suitable for the specified indoor service and enclose all unit components.

2.4.5.2 Outdoor Cabinet

Outdoor cabinets must be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.

2.4.6 Refrigerant Piping

Provide refrigerant piping in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.4.7 Ductwork

Provide ductwork in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.4.8 Temperature Controls

Provide temperature controls in accordance with Section 23 09 23.02 BACnet DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDNG CONTROL SYSTEMS.

2.5 UNITARY EQUIPMENT ACCESSORIES AND MISCELLANEOUS EQUIPMENT

2.6 FINISHES

2.6.1 Equipment and Components Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where stipulated in equipment specifications of this section, coat finned tube coils of the affected equipment as specified below. Apply coating at the premises of a company specializing in such work. Degrease and prepare for coating in accordance with the coating applicator's procedures for the type of metals involved. Completed coating must show no evidence of softening, blistering, cracking, crazing, flaking, loss of adhesion, or "bridging" between the fins.

2.6.1.1 Phenolic Coating

Provide a resin base thermosetting phenolic coating. Apply coating by immersion dipping of the entire coil. Provide a minimum of two coats. Bake or heat dry coils following immersions. After final immersion and

prior to final baking, spray entire coil with particular emphasis given to building up coating on sheared edges. Total dry film thickness must be 2.5 to 3.0 mils.

2.6.1.2 Chemical Conversion Coating with Polyelastomer Finish Coat

Dip coils in a chemical conversion solution to molecularly deposit a corrosion resistant coating by electrolysis action. Chemical conversion coatings must conform to MIL-DTL-5541, Class 1A. Cure conversion coating at a temperature of 110 to 140 degrees F for a minimum of 3 hours. Coat coil surfaces with a complex polymer primer with a dry film thickness of 1 mil. Cure primer coat for a minimum of 1 hour. Using dip tank method, provide three coats of a complex polyelastomer finish coat. After each of the first two finish coats, cure the coils for 1 hour. Following the third coat, spray a fog coat of an inert sealer on the coil surfaces. Total dry film thickness must be 2.5 to 3.0 mils. Cure finish coat for a minimum of 3 hours. Coating materials must have 300 percent flexibility, operate in temperatures of minus 50 to plus 220 degrees F, and protect against atmospheres of a pH range of 1 to 14.

2.6.1.3 Vinyl Coating

Apply coating using an airless fog nozzle. For each coat, make at least two passes with the nozzle. Materials to be applied are as follows:

a. Total dry film thickness, 6.5 mils maximum

b. Vinyl Primer, 24 percent solids by volume: One coat 2 mils thick

c. Vinyl Copolymer, 30 percent solids by volume: One coat 4.5 mils thick

2.6.2 Factory Applied Insulation

Refrigeration equipment must be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor in accordance with manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Insulation must be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.7 TESTS, INSPECTIONS, AND VERIFICATIONS

All manufactured units must be inspected and tested, and documentation provided to demonstrate that each unit is in compliance with ANSI/AHRI and UL requirements and that the minimum efficiency requirements of ASHRAE 90.1 - IP have been met.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

Perform work in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1and ASME BPVC SEC IX, the design, fabrication, and installation of the system must conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.2.1 Equipment

Provide refrigeration equipment conforming to ASHRAE 15 & 34. Provide necessary supports for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Isolate compressors from the building structure. If mechanical vibration isolators are not provided, provide vibration absorbing foundations. Each foundation must include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment must be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps must have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the combined pump, motor, and base weights. Isolators must be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Isolators must limit vibration to 10 percent at lowest equipment rpm. Provide lines connected to pumps mounted on pedestal blocks with flexible connectors. Provide foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.3 CLEANING AND ADJUSTING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters must be provided for all fans that are operated during construction, and new filters must be installed after all construction dirt has been removed from the building. System must be maintained in this clean condition until final acceptance. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing must be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4 TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total 4 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests.

a. Submit a schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

b. Submit the field posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

c. The posted instructions must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations. Submit 2 complete copies of an operation manual in bound 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets must include the manufacturer's name, model number, and parts list. The manuals must include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

d. Submit 2 complete copies of maintenance manual in bound 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals must include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

3.5 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems must be tested and charged as specified in Section 23 23 00 REFRIGERANT PIPING. Packaged refrigerant systems which are factory charged must be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems must be tested for leaks with a halide torch or an electronic leak detector. Submit 2 copies of each test containing the information described below in bound 8-1/2 by 11 inch booklets. Individual reports must be submitted for the refrigerant system tests.

a. The date the tests were performed.
b. A list of equipment used, with calibration certifications.
c. Initial test summaries.
d. Repairs/adjustments performed.
e. Final test results.

3.5.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system must immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances must the refrigerant be discharged into the atmosphere.

3.5.2 Contractor's Responsibility

Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps must include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time must more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year must be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.6 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Two copies of the report provided in bound 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system.

For equipment providing heating and cooling the system performance tests must be performed during the heating and cooling seasons.

a. Submit a schedule, at least 2 weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test. Tests must cover a period of not less than 48 hours for each system and must demonstrate that the entire system is functioning in accordance with the drawings and specifications.

b. Make corrections and adjustments, as necessary, tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, install and tighten service valve seal caps and blanks over gauge points. Replace any refrigerant lost during the system startup.

c. If tests do not demonstrate satisfactory system performance, correct deficiencies and retest the system. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test.

d. Coordinate field tests with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit 2 copies of the report provided in bound 8-1/2 by 11 inch booklets. The report must document compliance

with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Submit the report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart):

(1) Date and outside weather conditions.

(2) The load on the system based on the following:

(a) The refrigerant used in the system.
(b) Condensing temperature and pressure.
(c) Suction temperature and pressure.
(d) Ambient, condensing and coolant temperatures.
(e) Running current, voltage and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of operating and safety controls.

(4) Thermostatic expansion valve superheat - value as determined by field test.

(5) Subcooling.

(6) High and low refrigerant temperature switch set-points

(7) Low oil pressure switch set-point.

(8) Defrost system timer and thermostat set-points.

(9) Moisture content.

(10) Capacity control set-points.

(11) Field data and adjustments which affect unit performance and energy consumption.

(12) Field adjustments and settings which were not permanently marked as an integral part of a device.

3.7 MAINTENANCE

3.7.1 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

3.7.2 Maintenance Service

Submit a certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of

the contract.

-- End of Section --

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SECTION 23 82 46.00 40

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05/17

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SECTION 23 82 46.00 40

ELECTRIC UNIT HEATERS
05/17

PART 1 GENERAL

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to work specified in this section.

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

UL SOLUTIONS (UL)

UL 1996	(2009; Reprint Aug 2022) UL Standard for Safety Electric Duct Heaters

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Preinstallation Meetings

The Contracting Officer will schedule a preinstallation meeting within 30 days of Contract Award. Provide the following for review and approval:

a. Submit fabrication drawings for electric heaters, indicating the fabrication and assembly details to be performed in the factory.

b. Submit manufacturer's instructions for electric heaters, stating the special provisions necessary to install equipment components and system packages. Detail the impedances, hazards and safety precautions within the special notices.

1.3 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

SD-03 Product Data

Performance Data; G, DO

Electric Unit Heaters; G, DO

Heating Element

Controls; G, DO

Casings

Propellers and Motors; G, DO

SD-08 Manufacturer's Instructions

Manufacturer's InstructionsG, RO

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide suspended electric unit heaters, and arrange for the discharge of air as indicated.

Provide electric unit heaters with at least the indicated capacity and ensure that they conform to the requirements specified herein. Ensure that the electric unit heaters are factory-prewired and ready for field terminal connections.

Ensure products conform to the requirements of UL 1996 for electric unit heaters.

Submit performance data for electric heaters, including use life, test, system functional flows, safety features, and mechanical automated details.

2.2 COMPONENTS

2.2.1 Heating Element

Provide a heating element constructed of a resistance wire insulated by highly compacted refractory insulation protected by a sealed metallic-finned sheath. Provide component materials as follows:

a. Provide a resistance wire of not less than 20-helix wound alloy of approximately 80-percent nickel and 20-percent chromium.

b. Provide a refractory insulation of magnesium oxide with a resistance of not less than 50,000 ohms after exposure to an ambient temperature and humidity of 90 degrees F and 85 plus or minus 5-percent relative humidity, respectively, for not less than 24 hours.

c. Provide a sheathing consisting of aluminum fins cast around an internal steel sheath containing refractory insulation and resistance wire or carbon-steel fins permanently attached to a tubular carbon-steel sheath containing refractory insulation and resistance wire and with external surfaces porcelainized.

2.2.2 Controls

Provide wall-mounted thermostats complete with thermometer, mechanical high-limit stop, calibrated operator, and an adjustable heater to prevent

override of space temperature with a range between 40 and 105 degrees F and a differential not exceeding 1.5 degrees F. Provide a thermostat rated for operation at 24 volts, 60 hertz. Provide transformers, wiring, and devices necessary to meet this requirement. Provide a casing finish in brushed chrome .

2.2.3 Propellers and Motors

Provide propellers with blades statically and dynamically balanced to within 0.5 percent. Provide units with fan-inlet safety guards.

Ensure that propellers and motors are AMCA-certified for air performance and noise level.

Protect motors against damage by the heating element and resilient mount.

Provide the manufacturer's standard motor identification plate.

Provide the manufacturer's standard motor speed and control.

PART 3 EXECUTION

3.1 INSTALLATION

Install unit heaters in accordance with the manufacturer's instructions at the mounting heights indicated.

3.1.1 Casings

Provide casings with smoothly contoured propeller orifice rings of at least 20-gage cold-rolled carbon steel. Provide a casing surface finish with phosphate pretreatment, prime coating, and baked-enamel finish.

3.1.2 Air Distribution

Provide horizontal units with adjustable single- or double-deflection louvers.

3.2 FIELD QUALITY CONTROL

Demonstrate in the presence of the Contracting Officer that the unit heaters operate satisfactorily.

Cycle unit heaters five times, from start to operating thermal conditions to off, to verify adequacy of construction, system controls, and component performance.

Conduct an operational test for a minimum of 6 hours.

-- End of Section --

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SECTION 25 05 11.01

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05/21, CHG 1: 08/23

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SECTION 25 05 11.01

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC
05/21, CHG 1: 08/23

PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference only and enables coordination of the requirements of this Section with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

This Section refers to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs). STIGs and SRGs are available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/ and an SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this Section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this Section associated with this project. Different versions have requirements applicable to different control systems. This specific Section applies only to the following control systems: Heating, Ventilation, and Air Conditioning (HVAC).

1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other Sections which specify control systems. This Section adds cybersecurity requirements to the control systems specified in other Sections, and as these requirements are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.

In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the Contracting Officer Representative to determine which requirement applies to the project.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.1x	(2010) Local and Metropolitan Area Networks - Port Based Network Access Control

INTERNET ENGINEERING TASK FORCE (IETF)

IETF RFC 2819	(2000) Remote Network Monitoring (RMON) Management Information Base (MIB)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST FIPS 140-2	(2001) Security Requirements for Cryptographic Modules
NIST FIPS 201-2	(2013) Personal Identity Verification (PIV) of Federal Employees and Contractors

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 8551.01	(2014) Ports, Protocols, and Services Management (PPSM)
DTM 08-060	(2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement

1.4 DEFINITIONS

1.4.1 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Administrator Account'.

1.4.2 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows

b. a device running a non-embedded version of MacOS

c. a device running a non-embedded version of Linux

d. a device running a version or derivative of the Android Operating

System, where Android is considered separate from Linux

e. a device running a version of Apple iOS

Unless otherwise indicated or clear from context use of the word "device" in this Section includes computers.

1.4.3 Controller

A device other than a computer or Ethernet switch.

1.4.4 Mission Space

A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a VAV box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an AHU in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.

1.4.5 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network.

1.4.6 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

1.4.6.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

1.4.7 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

1.4.8 User Account Support Levels

The support for user accounts is categorized in this Section as one of three levels:

1.4.8.1 FULLY Supported

Device supports configurable individual accounts. Accounts can be created, deleted, modified, etc. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

1.4.8.2 MINIMALLY Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which MINIMALLY support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configuration; and b) a room lighting control touchpad interface that has a single account.

1.4.8.3 NOT Supported

Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.

1.4.9 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.4.10 Card Reader

A card reader is an input/output device whose primary function is to assist in two-factor authentication. A card reader must have an interface to read data from a card and may be able to write data to a card. A card reader may have a means (such as buttons, keypad, touchscreen, etc.) for a user to input a PIN or password, as well as a limited display.

1.4.11 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate its

user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the user interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter data, which is the "privilege" of the user interface (where effective privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the user interface and the specific account the user is logged into).

1.4.11.1 Local User Interface

A Local User Interface is a user interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

1.4.11.2 Remote User Interface

A Remote User Interface implements a Client/Server model where the physical hardware the user interacts with (Client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the Client. The Client and Server communicate via a network connection. A common example of a remote user interface is a web-based interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a Client on the same hardware as the Server. What is important is that a) the Client may be on different hardware than the Server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

1.4.11.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.4.11.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.11.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of LIMITED UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.11.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Full Local User Interface while a browser-based front end is a Full Remote User Interface.

1.4.11.3.4 View-Only User Interface

See Read-Only User Interface

1.4.11.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.11.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.11.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Ultimately, whether a specific user interface is considered a Privileged User Interface must be determined by usage. Unless otherwise specified, user interfaces can be determined to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. Full User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allows for

modification or deletion of audit logs are privileged user interface.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.12 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, 900 MHz radio, 2.4 GHz, free space optical, point-to-point laser, and IR.

1.4.13 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with The Contracting Office Representative (COR).

a. Government Computer Access Point of Contact: The Contracting Office Representative (COR)

b. HTTPS Certificate Point of Contact: The Contracting Office Representative (COR)

c. Password Point of Contact: The Contracting Office Representative (COR)

1.5.2 Coordination

Coordinate the execution of this Section with the execution of all other Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

b. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

c. The Cybersecurity Interconnection Schedule must be coordinated with other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.

d. Cybersecurity testing support must be coordinated across control systems and with the Government cybersecurity testing schedule.

e. Passwords must be coordinated with the indicated contact for the project site.

f. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Device Account Lock Exception Request; G, HNC

Multiple Ethernet Connection Device Request; G, HNC

Contractor Computer Cybersecurity Compliance Statements; G, HNC

Contractor Temporary Network Cybersecurity Compliance Statements; G, HNC

Cybersecurity Interconnection Schedule; G, HNC

Proposed STIG and SRG Applicability Report; G, HNC

Resumes and Certifications; G, HNC

SD-02 Shop Drawings

Network Communication Report; G, HNC

Cybersecurity Riser Diagram; G, HNC

SD-03 Product Data

Control System Cybersecurity Documentation; G, HNC

SD-06 Test Reports

Control System Cybersecurity Testing Procedures; G, HNC

Control System Cybersecurity Testing Report; G, HNC

SD-07 Certificates

Software Licenses; G, HNC

SD-11 Closeout Submittals

Confidential Password Report; G, RO

Enclosure Keys; G, RO

Software and Configuration Backups; G, HNC

Auditing Front End Software; G, HNC

Device Audit Record Upload Software; G, HNC

System Maintenance Tool Software; G, HNC

Control System Scanning Tools; G, HNC

STIG, SRG and Vendor Guide Compliance Result Report; G, HNC

Control System Inventory Report; G, HNC

Integrity Verification Software; G, HNC

1.6.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.7 QUALITY CONTROL

1.7.1 Qualifications

For the positions listed below, Resumes and Certifications shall be submitted to the Government within 14 days after notice to proceed. All certifications must be in effect prior to being hired.

These positons may serve across the contract.

1.7.1.1 Cybersecurity Subject Matter Expert

The individual will oversee all work within this specification and is responsible for verifying all submittals of the integrator and overseeing any system cybersecurity hardening. This position requires that the individual currently meets Information Assurance Manager Level II (IAM-II) Certification in accordance with DoDI 8570 Information Workforce Improvement Program and DoDI 8140 Cyberspace Workforce Improvement Program.

Individuals for this position should have experience securing DoD Systems and with the Risk Management Framework (RMF). Control System Experiece is required.

1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.8.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model.

1.8.2 Cybersecurity Interconnection Schedule

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication. For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

1.8.3 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, including CM-7(3), CCI-000388.}

Provide a network communication report. For each networked device, document the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP, document all TCP and UDP ports used. For non-IP communications, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication Report as an editable Microsoft Excel file.

1.8.4 Control System Inventory Report

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Provide a Control System Inventory report using the Inventory Spreadsheet listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 documenting all devices, including networked devices, network infrastructure devices, non-networked devices, input devices (e.g. sensors) and output devices (e.g. actuators). For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Report as an editable Microsoft Excel file.

1.8.5 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For all ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

If any or all of these are provided under another Section, provide documentation indicating this and referencing those submittals.

1.8.6 Cybersecurity Riser Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity riser diagram of the complete control system including all network and device hardware. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in one-line format.

1.8.7 STIG, SRG and Vendor Guide Compliance Result Report

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, provide a result report documenting compliance with the STIG or SRG requirements. For components which are scannable by the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), provide the SCAP report and raw scan results.

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.8.8 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5(a),SA-5(b),SA-5(c), SA-22(b); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131, CCI-003374}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.8.8.1 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

i. Documentation of the published last date of support by the manufacturer or indication that a published date is not available. {For Government Reference Only: relates to CCI-003374}

1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the project site for a period of no less than 5 years, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or

higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided

1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, CA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet following requirement throughout the construction process.

1.10.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must be scanned using the installed software at least once per day.

1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.10.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.10.1.6 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements

must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

All products used on this project must meet the indicated requirements, but not all products specified here will be required by every project.

2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

2.1.1 Required Functionality

Switches must:

a. Copper Ethernet ports must auto negotiate for 10, 100 and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address and limit the number of MAC addresses to one MAC address per port.

c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819

e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.

f. Support authentication via RADIUS server (for management and 802.1x)

g. Support IEEE 802.1x network login.

2.1.2 Configuration Requirements

Switches must:

a. Support configuration save and restore.

b. Support both manual IP address assignment and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.

d. Support the ability to lock configuration capability to a dedicated management port.

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined

in this Section.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with required functionality or another requirement of this Section.

3.2 NETWORK REQUIREMENTS

3.2.1 Information Flow Enforcement In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

3.2.2 Wireless and Wired Broadcast Communication

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-001449}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication.

3.2.3 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.4 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.

3.2.4.1 IP Network Routers

Do not install any device that performs IP routing.

3.2.4.2 IP Devices With Multiple Ethernet Connection

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.5 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.

For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure that IP network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.

3.2.6 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

3.2.6.1 Default Requirements for Control System Devices

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: Devices using HTTP as a control protocol must use HTTPS instead.

3.2.7 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764.
For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification.

3.3.1.1 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface must at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface must at FULLY support user accounts.

e. For table entries of "KEY": The user interface must have physical security in the form of either a key lock on the interface itself or be furnished inside a locked enclosure. Where this is required for a read only interface, this lock must prevent viewing of data on the interface; for other interfaces, this lock must prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data that can be directly altered by the interface, as well as mechanical and/or

electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" must meet both the requirement indicated for X and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface must both MINIMALLY support accounts and have physical security.

h. Entries of the form "X or Y" must meet either the requirement indicated for X or the requirement indicated for Y.

3.3.1.1.1 Default Requirements for Other Control Systems

For control system devices where User Interface Requirements are not otherwise indicated in this Section, use the Default User Interface Requirements tables.

Default User Interface Requirements for MODERATE Impact Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	MINIMALLY
Local Limited, Privileged	MINIMALLY and Physical Security
Local Full	MINIMALLY and Physical Security
Remote Read Only	None Required
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing must be configured as indicated.

3.3.1.2.1 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity.

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices must meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account accountafter five consecutive failed login attempts and must unlock the user account after 60 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when three unsuccessful logon attempts occur within a 15 minute interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for 1 hour and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network and have a local user interface must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels must be machine printed or engraved, plastic or metal, designed for permanent installation, must use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session Termination must result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this Section or display a publicly viewable image or blank screen. User Interfaces must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen. No interaction with the user interface must be possible until either a) the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must be terminated and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Controllers

Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after 30 minutes of inactivity.

Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must also support timed initiation of Session Termination, with Session Termination initiated at 30 minutes of inactivity.

3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions except read-only actions by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6 Physical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1 Physical Security for Media

3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.2 Physical Security for Devices

Install all devices which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the system, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

For MODERATE Impact Systems: Devices and software must not use cached authenticators.

3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.3 User Identification and Authentication for Specific Devices

There are no additional device specific user interface requirements

3.4.4 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.5 Password-Based Authentication Requirements

3.4.5.1 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts and supporting password-based

authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.2 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.3 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of four characters.

3.4.5.4 Password Configuration and Reporting

For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.4.6 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

3.5 CYBERSECURITY AUDITING

3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-14(b), AU-14(1), AU-14(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-001230, CCI-000133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Default Requirements for Control System Controllers

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.1.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.1.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

f. All kernel module load, unload, and restart

g. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.1.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.1.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

The project site currently has the following software to support control system auditing: none. If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another Section, furnish the Auditing Front End Software media and license for subsequent Government installation. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other Sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to 2 seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For controllers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.

3.5.4.1 Device Audit Record Upload Software

For each device required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In case of an audit failure, if possible, continue to collect audit records by overwriting existing audit records.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the network communication report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

3.6.1 Device Capabilities

Do not provide devices with remote user interfaces or full user interfaces

where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

For MODERATE Impact Systems: Do not provide (install) software that is not specifically required to meet a contract requirement. Do not implement functionality within software
that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-12, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Default Requirements for MODERATE Impact Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Mobile Code In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161,

CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal.

For software provided and licensed to the Government under the requirements of another Section, submit a statement indicating the Section and Submittal under which the software was provided. For software provided to meet the requirements of this Section and not provided and licensed under another Section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit one hard copy of the software user manual for each piece of software.

3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSs) as a source of device power.

3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices must be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

3.11.1 Controllers

Provide controllers that are scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information must contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

Devices in the following systems which implement PIV must be on the NIST FIPS 201-2 approved product list (https://www.idmanagement.gov/approved-products-list/): NONE.

3.13 SYSTEM AND INTEGRATION INTEGRITY

3.13.1 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to CM-5(3); CCI-001749, CCI-002704, CCI-002726}

If there exists Integrity Verification Software that can check boot process, software,
firmware, or information in the control system and verify its integrity, provide it. If no such software exists provide a statement to this affect in lieu of the software.

3.14 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d),

SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.14.1 Control System Cybersecurity Testing Procedures

Prepare Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section.

Submit 4 copies of the Control System Cybersecurity Testing Procedures. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.14.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this Section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.14.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results.

Submit four copies of the Control System Cybersecurity Testing Report. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package.

3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other Sections, provide a minimum of eight hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.16 CYBERSECURITY TRAINING

Provide eight hours of classroom and hands-on training for six Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.

The Government will provide the training location. Training must cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

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SECTION 25 05 11.02

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - FUEL CONTROL
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PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference only and enables coordination of the requirements of this Section with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

This Section refers to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs). STIGs and SRGs are available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/ and an SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this Section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this Section associated with this project. Different versions have requirements applicable to different control systems. This specific Section applies only to the following control systems: Fuel Control Systems: Pumping, Leak Detection, Tank Guages.

1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other Sections which specify control systems. This Section adds cybersecurity requirements to the control systems specified in other Sections, and as these requirements are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.

In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the Contracting Officer Representative to determine which requirement applies to the project.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.1x	(2010) Local and Metropolitan Area Networks - Port Based Network Access Control

INTERNET ENGINEERING TASK FORCE (IETF)

IETF RFC 2819	(2000) Remote Network Monitoring (RMON) Management Information Base (MIB)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST FIPS 140-2	(2001) Security Requirements for Cryptographic Modules
NIST FIPS 201-2	(2013) Personal Identity Verification (PIV) of Federal Employees and Contractors

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 8551.01	(2014) Ports, Protocols, and Services Management (PPSM)
DTM 08-060	(2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement

1.4 DEFINITIONS

1.4.1 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Administrator Account'.

1.4.2 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows

b. a device running a non-embedded version of MacOS

c. a device running a non-embedded version of Linux

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux

e. a device running a version of Apple iOS

Unless otherwise indicated or clear from context use of the word "device" in this Section includes computers.

1.4.3 Controller

A device other than a computer or Ethernet switch.

1.4.4 Mission Space

A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a VAV box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an AHU in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.

1.4.5 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network.

1.4.6 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

1.4.6.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

1.4.7 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

1.4.8 User Account Support Levels

The support for user accounts is categorized in this Section as one of three levels:

1.4.8.1 FULLY Supported

Device supports configurable individual accounts. Accounts can be created, deleted, modified, etc. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

1.4.8.2 MINIMALLY Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which MINIMALLY support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configuration; and b) a room lighting control touchpad interface that has a single account.

1.4.8.3 NOT Supported

Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.

1.4.9 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.4.10 Card Reader

A card reader is an input/output device whose primary function is to assist in two-factor authentication. A card reader must have an interface to read data from a card and may be able to write data to a card. A card reader may have a means (such as buttons, keypad, touchscreen, etc.) for a user to input a PIN or password, as well as a limited display.

1.4.11 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate its user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the user interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter data, which is the "privilege" of the user interface (where effective

privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the user interface and the specific account the user is logged into).

1.4.11.1 Local User Interface

A Local User Interface is a user interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

1.4.11.2 Remote User Interface

A Remote User Interface implements a Client/Server model where the physical hardware the user interacts with (Client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the Client. The Client and Server communicate via a network connection. A common example of a remote user interface is a web-based interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a Client on the same hardware as the Server. What is important is that a) the Client may be on different hardware than the Server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

1.4.11.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.4.11.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.11.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of LIMITED UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.11.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Full Local User Interface while a browser-based front end is a Full Remote User Interface.

1.4.11.3.4 View-Only User Interface

See Read-Only User Interface

1.4.11.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.11.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.11.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Ultimately, whether a specific user interface is considered a Privileged User Interface must be determined by usage. Unless otherwise specified, user interfaces can be determined to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. Full User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allows for modification or deletion of audit logs are privileged user interface.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.12 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, 900 MHz radio, 2.4 GHz, free space optical, point-to-point laser, and IR.

1.4.13 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with The Contracting Office Representative (COR).

a. Government Computer Access Point of Contact: The Contracting Office Representative (COR)

b. HTTPS Certificate Point of Contact: The Contracting Office Representative (COR)

c. Password Point of Contact: The Contracting Office Representative (COR)

1.5.2 Coordination

Coordinate the execution of this Section with the execution of all other Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

b. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

c. The Cybersecurity Interconnection Schedule must be coordinated with other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.

d. Cybersecurity testing support must be coordinated across control systems and with the Government cybersecurity testing schedule.

e. Passwords must be coordinated with the indicated contact for the project site.

f. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Device Account Lock Exception Request; G, HNC

Multiple Ethernet Connection Device Request; G, HNC

Contractor Computer Cybersecurity Compliance Statements; G, HNC

Contractor Temporary Network Cybersecurity Compliance Statements; G, HNC

Cybersecurity Interconnection Schedule; G, HNC

Proposed STIG and SRG Applicability Report; G, HNC

Resumes and Certifications; G, HNC

SD-02 Shop Drawings

Network Communication Report; G, HNC

Cybersecurity Riser Diagram; G, HNC

SD-03 Product Data

Control System Cybersecurity Documentation; G, HNC

SD-06 Test Reports

Control System Cybersecurity Testing Procedures; G, HNC

Control System Cybersecurity Testing Report; G, HNC

SD-07 Certificates

Software Licenses; G, HNC

SD-11 Closeout Submittals

Confidential Password Report; G, RO

Enclosure Keys; G, RO

Software and Configuration Backups; G, HNC

Auditing Front End Software; G, HNC

Device Audit Record Upload Software; G, HNC

System Maintenance Tool Software; G, HNC

Control System Scanning Tools; G, HNC

STIG, SRG and Vendor Guide Compliance Result Report; G, HNC

Control System Inventory Report; G, HNC

Integrity Verification Software; G, HNC

1.6.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.7 QUALITY CONTROL

1.7.1 Qualifications

For the positions listed below, Resumes and Certifications shall be submitted to the Government within 14 days after notice to proceed. All certifications must be in effect prior to being hired.

These positons may serve across the contract.

1.7.1.1 Cybersecurity Subject Matter Expert

The individual will oversee all work within this specification and is responsible for verifying all submittals of the integrator and overseeing any system cybersecurity hardening. This position requires that the individual currently meets Information Assurance Manager Level II (IAM-II) Certification in accordance with DoDI 8570 Information Workforce Improvement Program and DoDI 8140 Cyberspace Workforce Improvement Program.

Individuals for this position should have experience securing DoD Systems and with the Risk Management Framework (RMF). Control System Experiece is required.

1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.8.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model.

1.8.2 Cybersecurity Interconnection Schedule

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication. For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

1.8.3 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, including CM-7(3), CCI-000388.}

Provide a network communication report. For each networked device, document the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP, document all TCP and UDP ports used. For non-IP communications, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication Report as an editable Microsoft Excel file.

1.8.4 Control System Inventory Report

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Provide a Control System Inventory report using the Inventory Spreadsheet listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 documenting all devices, including networked devices, network infrastructure devices, non-networked devices, input devices (e.g. sensors) and output devices (e.g. actuators). For each device provide all applicable information for which there is a field on the spreadsheet in

accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Report as an editable Microsoft Excel file.

1.8.5 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For all ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

If any or all of these are provided under another Section, provide documentation indicating this and referencing those submittals.

1.8.6 Cybersecurity Riser Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity riser diagram of the complete control system including all network and device hardware. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in one-line format.

1.8.7 STIG, SRG and Vendor Guide Compliance Result Report

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, provide a result report documenting compliance with the STIG or SRG requirements. For components which are scannable by the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), provide the SCAP report and raw scan results.

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.8.8 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5(a),SA-5(b),SA-5(c), SA-22(b); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131, CCI-003374}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.8.8.1 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity

Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

i. Documentation of the published last date of support by the manufacturer or indication that a published date is not available. {For Government Reference Only: relates to CCI-003374}

1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the project site for a period of no less than 5 years, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided

1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, CA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet following requirement throughout the construction process.

1.10.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must be scanned using the installed software at least once per day.

1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.10.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.10.1.6 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

All products used on this project must meet the indicated requirements, but not all products specified here will be required by every project.

2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

2.1.1 Required Functionality

Switches must:

a. Copper Ethernet ports must auto negotiate for 10, 100 and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address and limit the number of MAC addresses to one MAC address per port.

c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819

e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.

f. Support authentication via RADIUS server (for management and 802.1x)

g. Support IEEE 802.1x network login.

2.1.2 Configuration Requirements

Switches must:

a. Support configuration save and restore.

b. Support both manual IP address assignment and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.

d. Support the ability to lock configuration capability to a dedicated management port.

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with required functionality or another requirement of this Section.

3.2 NETWORK REQUIREMENTS

3.2.1 Information Flow Enforcement In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

3.2.2 Wireless and Wired Broadcast Communication

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-001449}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication.

3.2.3 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.4 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP

networks if the same control functionality is available through the use of non-IP networks.

3.2.4.1 IP Network Routers

Do not install any device that performs IP routing.

3.2.4.2 IP Devices With Multiple Ethernet Connection

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.5 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.

For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure that IP network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.

3.2.6 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

3.2.6.1 Default Requirements for Control System Devices

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: Devices using HTTP as a control protocol must use HTTPS instead.

3.2.7 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764.
For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification.

3.3.1.1 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface must at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface must at FULLY support user accounts.

e. For table entries of "KEY": The user interface must have physical security in the form of either a key lock on the interface itself or be furnished inside a locked enclosure. Where this is required for a read only interface, this lock must prevent viewing of data on the interface; for other interfaces, this lock must prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data that can be

directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" must meet both the requirement indicated for X and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface must both MINIMALLY support accounts and have physical security.

h. Entries of the form "X or Y" must meet either the requirement indicated for X or the requirement indicated for Y.

3.3.1.1.1 Default Requirements for Other Control Systems

For control system devices where User Interface Requirements are not otherwise indicated in this Section, use the Default User Interface Requirements tables.

Default User Interface Requirements for MODERATE Impact Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	MINIMALLY
Local Limited, Privileged	MINIMALLY and Physical Security
Local Full	MINIMALLY and Physical Security
Remote Read Only	None Required
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing must be configured as indicated.

3.3.1.2.1 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity.

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices must meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account accountafter five consecutive failed login attempts and must unlock the user account after 60 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when three unsuccessful logon attempts occur within a 15 minute interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for 1 hour and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network and have a local user interface must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels must be machine printed or engraved, plastic or metal, designed for permanent installation, must use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session Termination must result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this Section or display a publicly viewable image or blank screen. User Interfaces must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen. No interaction with the user interface must be possible until either a) the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must be terminated and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Controllers

Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after 30

minutes of inactivity.

Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must also support timed initiation of Session Termination, with Session Termination initiated at 30 minutes of inactivity.

3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions except read-only actions by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6 Physical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1 Physical Security for Media

3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.2 Physical Security for Devices

Install all devices which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the system, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

For MODERATE Impact Systems: Devices and software must not use cached authenticators.

3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.3 User Identification and Authentication for Specific Devices

There are no additional device specific user interface requirements

3.4.4 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.5 Password-Based Authentication Requirements

3.4.5.1 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts and supporting password-based

authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.2 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.3 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of four characters.

3.4.5.4 Password Configuration and Reporting

For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.4.6 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

3.5 CYBERSECURITY AUDITING

3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-14(b), AU-14(1), AU-14(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-001230, CCI-000133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Default Requirements for Control System Controllers

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.1.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.1.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

f. All kernel module load, unload, and restart

g. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.1.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.1.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

The project site currently has the following software to support control system auditing: none. If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another Section, furnish the Auditing Front End Software media and license for subsequent Government installation. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other Sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to 2 seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For controllers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.

3.5.4.1 Device Audit Record Upload Software

For each device required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In case of an audit failure, if possible, continue to collect audit records by overwriting existing audit records.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the network communication report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

3.6.1 Device Capabilities

Do not provide devices with remote user interfaces or full user interfaces

where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

For MODERATE Impact Systems: Do not provide (install) software that is not specifically required to meet a contract requirement. Do not implement functionality within software
that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-12, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Default Requirements for MODERATE Impact Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Mobile Code In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161,

CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal.

For software provided and licensed to the Government under the requirements of another Section, submit a statement indicating the Section and Submittal under which the software was provided. For software provided to meet the requirements of this Section and not provided and licensed under another Section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit one hard copy of the software user manual for each piece of software.

3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSs) as a source of device power.

3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices must be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

3.11.1 Controllers

Provide controllers that are scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information must contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

Devices in the following systems which implement PIV must be on the NIST FIPS 201-2 approved product list (https://www.idmanagement.gov/approved-products-list/): NONE.

3.13 SYSTEM AND INTEGRATION INTEGRITY

3.13.1 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to CM-5(3); CCI-001749, CCI-002704, CCI-002726}

If there exists Integrity Verification Software that can check boot process, software,
firmware, or information in the control system and verify its integrity, provide it. If no such software exists provide a statement to this affect in lieu of the software.

3.14 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d),

SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.14.1 Control System Cybersecurity Testing Procedures

Prepare Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section.

Submit 4 copies of the Control System Cybersecurity Testing Procedures. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.14.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this Section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.14.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results.

Submit four copies of the Control System Cybersecurity Testing Report. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package.

3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other Sections, provide a minimum of eight hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.16 CYBERSECURITY TRAINING

Provide eight hours of classroom and hands-on training for six Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.

The Government will provide the training location. Training must cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

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SECTION 25 05 11.03

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - FIRE ALARM
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PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference only and enables coordination of the requirements of this Section with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this Section associated with this project. Different versions have requirements applicable to different control systems. This specific Section applies only to the following control systems: Fire Alarm.

The control system as designed does not have traditional IT (computers, servers, Ethernet switches) as part of the design.

1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other Sections which specify control systems. This Section adds cybersecurity requirements to the control systems specified in other Sections, and as these requirements are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.

In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the Contracting Officer Representative to determine which requirement applies to the project.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST FIPS 140-2 (2001) Security Requirements for

	Cryptographic Modules
NIST FIPS 201-2	(2013) Personal Identity Verification (PIV) of Federal Employees and Contractors

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 8551.01	(2014) Ports, Protocols, and Services Management (PPSM)
DTM 08-060	(2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement

1.4 DEFINITIONS

1.4.1 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Administrator Account'.

1.4.2 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows

b. a device running a non-embedded version of MacOS

c. a device running a non-embedded version of Linux

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux

e. a device running a version of Apple iOS

Unless otherwise indicated or clear from context use of the word "device" in this Section includes computers.

1.4.3 Controller

A device other than a computer or Ethernet switch. For Fire Protection systems this includes fire alarm control panels, remote operating consoles, and remote annunciators.

1.4.4 Mission Space

A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a VAV box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an AHU in a mechanical room or on a rooftop may still be

considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.

1.4.5 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network.

1.4.6 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

1.4.6.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

1.4.7 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

1.4.8 User Account Support Levels

The support for user accounts is categorized in this Section as one of three levels:

1.4.8.1 FULLY Supported

Device supports configurable individual accounts. Accounts can be created, deleted, modified, etc. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

1.4.8.2 MINIMALLY Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, the accounts do not have to be the traditional "username and password" structure). These devices typically

only support role-based authentication.

Examples of devices which MINIMALLY support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configuration; and b) a room lighting control touchpad interface that has a single account.

1.4.8.3 NOT Supported

Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.

1.4.9 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.4.10 Card Reader

A card reader is an input/output device whose primary function is to assist in two-factor authentication. A card reader must have an interface to read data from a card and may be able to write data to a card. A card reader may have a means (such as buttons, keypad, touchscreen, etc.) for a user to input a PIN or password, as well as a limited display.

1.4.11 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate its user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the user interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter data, which is the "privilege" of the user interface (where effective privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the user interface and the specific account the user is logged into).

1.4.11.1 Local User Interface

A Local User Interface is a user interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full

User Interface".

1.4.11.2 Remote User Interface

A Remote User Interface implements a Client/Server model where the physical hardware the user interacts with (Client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the Client. The Client and Server communicate via a network connection. A common example of a remote user interface is a web-based interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a Client on the same hardware as the Server. What is important is that a) the Client may be on different hardware than the Server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

1.4.11.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.4.11.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.11.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of LIMITED UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with

other devices.

1.4.11.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Full Local User Interface while a browser-based front end is a Full Remote User Interface.

1.4.11.3.4 View-Only User Interface

See Read-Only User Interface

1.4.11.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.11.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.11.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Ultimately, whether a specific user interface is considered a Privileged User Interface must be determined by usage. Unless otherwise specified, user interfaces can be determined to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. User Interfaces that can inhibit or force the activation of a fire suppression system (e.g. such as for a pre-action or deluge system) are always privileged user interfaces. Other Full User interfaces for Fire Alarm Systems are privileged user interfaces as indicated and shown, or when another requirement of this Section establishes they are privileged. For all other systems, Full User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allows for modification or deletion of audit logs are privileged user interface.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.12 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, 900 MHz radio, 2.4 GHz, free space optical, point-to-point laser, and IR.

1.4.13 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with The Contracting Office Representative (COR).

1.5.2 Coordination

Coordinate the execution of this Section with the execution of all other Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

b. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

c. Cybersecurity testing support must be coordinated across control systems and with the Government cybersecurity testing schedule.

d. Passwords must be coordinated with the indicated contact for the project site.

e. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Device Account Lock Exception Request; G, HNC

Multiple Ethernet Connection Device Request; G, HNC

Contractor Computer Cybersecurity Compliance Statements; G, HNC

Contractor Temporary Network Cybersecurity Compliance Statements; G, HNC

Resumes and Certifications; G, HNC

SD-02 Shop Drawings

Network Communication Report; G, HNC

Cybersecurity Riser Diagram; G, HNC

SD-03 Product Data

Control System Cybersecurity Documentation; G, HNC

SD-06 Test Reports

Control System Cybersecurity Testing Procedures; G, HNC

Control System Cybersecurity Testing Report; G, HNC

SD-07 Certificates

Software Licenses; G, HNC

SD-11 Closeout Submittals

Confidential Password Report; G, RO

Enclosure Keys; G, RO

Software and Configuration Backups; G, HNC

Auditing Front End Software; G, HNC

Device Audit Record Upload Software; G, HNC

System Maintenance Tool Software; G, HNC

Control System Scanning Tools; G, HNC

Vendor Guide Compliance Result Report; G, HNC

Control System Inventory Report; G, HNC

Integrity Verification Software; G, HNC

1.6.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.7 QUALITY CONTROL

1.7.1 Qualifications

For the positions listed below, Resumes and Certifications shall be submitted to the Government within 14 days after notice to proceed. All certifications must be in effect prior to being hired.

These positons may serve across the contract.

1.7.1.1 Cybersecurity Subject Matter Expert

The individual will oversee all work within this specification and is responsible for verifying all submittals of the integrator and overseeing any system cybersecurity hardening. This position requires that the individual currently meets Information Assurance Manager Level II (IAM-II) Certification in accordance with DoDI 8570 Information Workforce Improvement Program and DoDI 8140 Cyberspace Workforce Improvement Program.

Individuals for this position should have experience securing DoD Systems and with the Risk Management Framework (RMF). Control System Experiece is required.

1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.8.1 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, including CM-7(3), CCI-000388.}

Provide a network communication report. For each networked device, document the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP, document all TCP and UDP ports used. For non-IP communications, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication Report as an editable Microsoft Excel file.

1.8.2 Control System Inventory Report

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Provide a Control System Inventory report using the Inventory Spreadsheet listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 documenting all networked devices, including network infrastructure

devices. For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Report as an editable Microsoft Excel file.

1.8.3 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

If any or all of these are provided under another Section, provide documentation indicating this and referencing those submittals.

1.8.4 Cybersecurity Riser Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity riser diagram of the complete control system including all network and device hardware. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in one-line format.

1.8.5 Vendor Guide Compliance Result Report

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.8.6 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5(a),SA-5(b),SA-5(c), SA-22(b); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131, CCI-003374}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.8.6.1 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

i. Documentation of the published last date of support by the manufacturer or indication that a published date is not available. {For Government Reference Only: relates to CCI-003374}

1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the project site for a period of no less than 5 years, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided

1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, CA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet following requirement throughout the construction process.

1.10.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must be scanned using the installed software at least once per day.

1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.10.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.10.1.6 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with required functionality or another requirement of this Section.

3.2 NETWORK REQUIREMENTS

3.2.1 Wireless and Wired Broadcast Communication for Fire Protection Systems

The use of wireless and wired broadcast communication for fire protection systems within a facility is prohibited. Wireless communication may be used to provide communication from the fire protection system in a facility to the central monitoring station.

3.2.2 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.3 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.

3.2.3.1 IP Network Routers

Do not install any device that performs IP routing.

3.2.3.2 IP Devices With Multiple Ethernet Connection

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.4 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.

3.2.5 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

3.2.5.1 Default Requirements for Control System Devices

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: Devices using HTTP as a control protocol must use HTTPS instead.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764. For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account.

All user interfaces FULLY supporting accounts must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification.

3.3.1.1 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface must at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface must at FULLY support user accounts.

e. For table entries of "KEY": The user interface must have physical security in the form of either a key lock on the interface itself or be furnished inside a locked enclosure. Where this is required for a read only interface, this lock must prevent viewing of data on the interface; for other interfaces, this lock must prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data that can be directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" must meet both the requirement indicated for X and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface must both MINIMALLY support accounts and have physical security.

h. Entries of the form "X or Y" must meet either the requirement indicated for X or the requirement indicated for Y.

3.3.1.1.1 Fire Protection Systems

User Interface Requirements for MODERATE Impact Fire Protection Systems	
User Interface Type	**Access Control Requirement** (See note 2)
Local Read Only	None Required
Local Limited, Non-privileged	KEY or MINIMALLY
Local Limited, Privileged	KEY and Physical Security
Local Full	KEY
Remote Read Only	MINIMALLY
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full	FULLY

User Interface Requirements for MODERATE Impact Fire Protection Systems	
User Interface Type	**Access Control Requirement** (See note 2)
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing must be configured as indicated.

3.3.1.2.1 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity.

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices must meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account accountafter five consecutive failed login attempts and must unlock the user account after 60 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when three unsuccessful logon attempts occur within a 15 minute interval.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network and have a local user interface must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels must be machine printed or engraved, plastic or metal, designed for permanent installation, must use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session Termination must result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this Section or display a publicly viewable image or blank screen. User Interfaces must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen.

No interaction with the user interface must be possible until either a) the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must be terminated and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Controllers

Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after 30 minutes of inactivity.

Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must also support timed initiation of Session Termination, with Session Termination initiated at 30 minutes of inactivity.

3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions except read-only actions by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6 Physical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1 Physical Security for Media

3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.1.3 Physical Security for Non-Network Media in Fire Protection Systems

For Fire Suppression Systems which can be inhibited or forced to activate by manipulation of non-network wiring, install all non-network media outside of mission space, including analog and binary instrumentation wiring and power wiring, in rigid metallic conduit.

3.3.6.2 Physical Security for Devices

Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of

mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.2.1 Physical Security for Devices in Fire Protection Systems

For Fire Suppression systems with a release panel, install all components of the suppression system either inside mission space, or within locked enclosures. Components of these systems include: release panel, any relay or interface panels, analog and binary inputs or outputs, control valves, manual valves.

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the system, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

For MODERATE Impact Systems: All devices and software must not use cached authenticators.

3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those

indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.3 User Identification and Authentication for Specific Devices

There are no additional device specific user interface requirements

3.4.4 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For user interfaces on a computer: inheriting the Identification and Authorization from the computer operating system, either by the operating system limiting access to specific applications by user, or by the application itself having permissions based on the user logged into the computer.

c. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client.

3.4.5 Password-Based Authentication Requirements

3.4.5.1 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts and supporting password-based authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.2 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of four characters.

3.4.5.3 Password Configuration and Reporting

For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Report in electronic format. Provide two hardcopies of the Password Report, each copy in its own sealed envelope.

3.4.6 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable.

3.5 CYBERSECURITY AUDITING

3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-14(b), AU-14(1), AU-14(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-001230, CCI-000133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Default Requirements for Control System Controllers

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.1.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.1.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

f. All kernel module load, unload, and restart

g. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.1.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.1.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

The project site currently has the following software to support control system auditing: none. If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another Section, furnish the Auditing Front End Software media and license for subsequent Government installation. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other Sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to 2 seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if

required to maintain normal operation.

For controllers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.

3.5.4.1 Device Audit Record Upload Software

For each device required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the network communication report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762}

3.6.1 Device Capabilities

Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

Do not provide (install) software that is not specifically required to meet a contract requirement. Do not implement functionality within software that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-12, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Default Requirements for MODERATE Impact Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Process Isolation and Boundary Protection in Moderate Impact Fire Protection Systems

{For Government Reference Only: This subpart relates to SC-7(a), SC-7(c), SC-7(4)(a), SC-7(4)(c), SC-7(5), SC-7(7), SC-7(9)(a), SC-7(11), SC-7(13), SC-7(13), SC-7(18); CCI-001097, CCI-001098, CCI-001102, CCI-002396, CCI-001109, CCI-002397, CCI-002398, CCI-002399, CCI-002403, CCI-001120, CCI-001119, CCI-001126}

3.7.3.1 Radio Interfaces for Fire Protection Systems

When radios interfacing a local fire protection system to a supervisory system are not NIST FIPS 140-2 validated, use a relay panel interface between the local fire protection system and the radio. Install and configure the relay panel to prohibit initiating any action within the local fire protection system other than causing the system to play a pre-recorded message or causing the system to play a live audio message. Install relays using the normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal.

3.7.3.2 Fire Suppression System Network Isolation

For fire suppression systems including a release panel, any network used in these systems must be dedicated to these systems and must be isolated from any other network, including other components of the Fire Alarm and Fire Suppression systems. Use only dry contacts and relays to transfer signals from these systems to any other systems. Install relays using the normally open contact such that they pass a signal when they close, and so that a relay that loses power or has a failed coil does not pass a signal.

3.8 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal.

For software provided and licensed to the Government under the requirements of another Section, submit a statement indicating the Section and Submittal under which the software was provided. For software provided to meet the requirements of this Section and not provided and licensed under another Section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit one hard copy of the software user manual for each piece of software.

3.9 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSs) as a source of device power.

3.9.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

3.10 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices must be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the

device, application, or functionality.

3.10.1 Controllers

Provide controllers that are scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information must contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.11 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

Devices in the following systems which implement PIV must be on the NIST FIPS 201-2 approved product list (https://www.idmanagement.gov/approved-products-list/): NONE.

3.12 SYSTEM AND INTEGRATION INTEGRITY

3.12.1 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to CM-5(3); CCI-001749, CCI-002704, CCI-002726}

If there exists Integrity Verification Software that can check boot process, software,
firmware, or information in the control system and verify its integrity, provide it. If no such software exists provide a statement to this affect in lieu of the software.

3.13 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.13.1 Control System Cybersecurity Testing Procedures

Prepare Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section.

Submit 4 copies of the Control System Cybersecurity Testing Procedures. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.13.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this Section. UNLESS GOVERNMENT

WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.13.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results.

Submit four copies of the Control System Cybersecurity Testing Report. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package.

3.14 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other Sections, provide a minimum of eight hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.15 CYBERSECURITY TRAINING

Provide eight hours of classroom and hands-on training for four Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.

The Government will provide the training location. Training must cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

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SECTION 25 05 11.04

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - INTERCOM/PUBLIC ADDRESS
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PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference only and enables coordination of the requirements of this Section with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

This Section refers to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs). STIGs and SRGs are available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/ and an SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this Section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this Section associated with this project. Different versions have requirements applicable to different control systems. This specific Section applies only to the following control systems: Intercom/Public Address.

1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other Sections which specify control systems. This Section adds cybersecurity requirements to the control systems specified in other Sections, and as these requirements are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.

In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the Contracting Officer Representative to determine which requirement applies to the project.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.1x	(2010) Local and Metropolitan Area Networks - Port Based Network Access Control

INTERNET ENGINEERING TASK FORCE (IETF)

IETF RFC 2819	(2000) Remote Network Monitoring (RMON) Management Information Base (MIB)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST FIPS 140-2	(2001) Security Requirements for Cryptographic Modules
NIST FIPS 201-2	(2013) Personal Identity Verification (PIV) of Federal Employees and Contractors

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 8551.01	(2014) Ports, Protocols, and Services Management (PPSM)
DTM 08-060	(2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement

1.4 DEFINITIONS

1.4.1 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Administrator Account'.

1.4.2 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows

b. a device running a non-embedded version of MacOS

c. a device running a non-embedded version of Linux

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux

e. a device running a version of Apple iOS

Unless otherwise indicated or clear from context use of the word "device" in this Section includes computers.

1.4.3 Controller

A device other than a computer or Ethernet switch.

1.4.4 Mission Space

A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a VAV box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an AHU in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.

1.4.5 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network.

1.4.6 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

1.4.6.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

1.4.7 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

1.4.8 User Account Support Levels

The support for user accounts is categorized in this Section as one of three levels:

1.4.8.1 FULLY Supported

Device supports configurable individual accounts. Accounts can be

created, deleted, modified, etc. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

1.4.8.2 MINIMALLY Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which MINIMALLY support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configuration; and b) a room lighting control touchpad interface that has a single account.

1.4.8.3 NOT Supported

Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.

1.4.9 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.4.10 Card Reader

A card reader is an input/output device whose primary function is to assist in two-factor authentication. A card reader must have an interface to read data from a card and may be able to write data to a card. A card reader may have a means (such as buttons, keypad, touchscreen, etc.) for a user to input a PIN or password, as well as a limited display.

1.4.11 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate its user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the user interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter data, which is the "privilege" of the user interface (where effective privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the user interface and the specific account the user is logged into).

1.4.11.1 Local User Interface

A Local User Interface is a user interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

1.4.11.2 Remote User Interface

A Remote User Interface implements a Client/Server model where the physical hardware the user interacts with (Client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the Client. The Client and Server communicate via a network connection. A common example of a remote user interface is a web-based interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a Client on the same hardware as the Server. What is important is that a) the Client may be on different hardware than the Server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

1.4.11.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.4.11.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.11.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination

of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of LIMITED UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.11.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Full Local User Interface while a browser-based front end is a Full Remote User Interface.

1.4.11.3.4 View-Only User Interface

See Read-Only User Interface

1.4.11.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.11.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.11.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Ultimately, whether a specific user interface is considered a Privileged User Interface must be determined by usage. Unless otherwise specified, user interfaces can be determined to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. Full User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allows for modification or deletion of audit logs are privileged user interface.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available

at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.12 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, 900 MHz radio, 2.4 GHz, free space optical, point-to-point laser, and IR.

1.4.13 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with The Contracting Office Representative (COR).

a. Government Computer Access Point of Contact: The Contracting Office Representative (COR)

b. HTTPS Certificate Point of Contact: The Contracting Office Representative (COR)

c. Password Point of Contact: The Contracting Office Representative (COR)

1.5.2 Coordination

Coordinate the execution of this Section with the execution of all other Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

b. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

c. Cybersecurity testing support must be coordinated across control systems and with the Government cybersecurity testing schedule.

d. Passwords must be coordinated with the indicated contact for the project site.

e. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Device Account Lock Exception Request; G, HNC

Multiple Ethernet Connection Device Request; G, HNC

Contractor Computer Cybersecurity Compliance Statements; G, HNC

Contractor Temporary Network Cybersecurity Compliance Statements; G, HNC

Proposed STIG and SRG Applicability Report; G, HNC

Resumes and Certifications; G, HNC

SD-02 Shop Drawings

Network Communication Report; G, HNC

Cybersecurity Riser Diagram; G, HNC

SD-03 Product Data

Control System Cybersecurity Documentation; G, HNC

SD-06 Test Reports

Control System Cybersecurity Testing Procedures; G, HNC

Control System Cybersecurity Testing Report; G, HNC

SD-07 Certificates

Software Licenses; G, HNC

SD-11 Closeout Submittals

Confidential Password Report; G, RO

Enclosure Keys; G, RO

Software and Configuration Backups; G, HNC

Auditing Front End Software; G, HNC

Device Audit Record Upload Software; G, HNC

System Maintenance Tool Software; G, HNC

Control System Scanning Tools; G, HNC

STIG, SRG and Vendor Guide Compliance Result Report; G, HNC

Control System Inventory Report; G, HNC

Integrity Verification Software; G, HNC

1.6.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.7 QUALITY CONTROL

1.7.1 Qualifications

For the positions listed below, Resumes and Certifications shall be submitted to the Government within 14 days after notice to proceed. All certifications must be in effect prior to being hired.

These positons may serve across the contract.

1.7.1.1 Cybersecurity Subject Matter Expert

The individual will oversee all work within this specification and is responsible for verifying all submittals of the integrator and overseeing any system cybersecurity hardening. This position requires that the individual currently meets Information Assurance Manager Level II (IAM-II) Certification in accordance with DoDI 8570 Information Workforce Improvement Program and DoDI 8140 Cyberspace Workforce Improvement Program.

Individuals for this position should have experience securing DoD Systems and with the Risk Management Framework (RMF). Control System Experiece is required.

1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.8.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model.

1.8.2 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, including CM-7(3), CCI-000388.}

Provide a network communication report. For each networked device, document the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For

each device using IP, document all TCP and UDP ports used. For non-IP communications, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication Report as an editable Microsoft Excel file.

1.8.3 Control System Inventory Report

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Provide a Control System Inventory report using the Inventory Spreadsheet listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 documenting all devices, including networked devices, network infrastructure devices, non-networked devices, input devices (e.g. sensors) and output devices (e.g. actuators). For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Report as an editable Microsoft Excel file.

1.8.4 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For all ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

If any or all of these are provided under another Section, provide documentation indicating this and referencing those submittals.

1.8.5 Cybersecurity Riser Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity riser diagram of the complete control system including all network and device hardware. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in one-line format.

1.8.6 STIG, SRG and Vendor Guide Compliance Result Report

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, provide a result report

documenting compliance with the STIG or SRG requirements. For components which are scannable by the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), provide the SCAP report and raw scan results.

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.8.7 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5(a),SA-5(b),SA-5(c), SA-22(b); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131, CCI-003374}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.8.7.1 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

i. Documentation of the published last date of support by the manufacturer or indication that a published date is not available. {For Government Reference Only: relates to CCI-003374}

1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the project site for a period of no less than 5 years, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided

1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, CA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet following requirement throughout the construction process.

1.10.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must be scanned using the installed software at least once per day.

1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.10.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.10.1.6 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

All products used on this project must meet the indicated requirements, but not all products specified here will be required by every project.

2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

2.1.1 Required Functionality

Switches must:

a. Copper Ethernet ports must auto negotiate for 10, 100 and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address and limit the number of MAC addresses to one MAC address per port.

c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819

e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.

f. Support authentication via RADIUS server (for management and 802.1x)

g. Support IEEE 802.1x network login.

2.1.2 Configuration Requirements

Switches must:

a. Support configuration save and restore.

b. Support both manual IP address assignment and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.

d. Support the ability to lock configuration capability to a dedicated management port.

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with required functionality or another requirement of this Section.

3.2 NETWORK REQUIREMENTS

3.2.1 Information Flow Enforcement In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

3.2.2 Wireless and Wired Broadcast Communication

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-001449}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication.

3.2.3 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.4 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.

3.2.4.1 IP Network Routers

Do not install any device that performs IP routing.

3.2.4.2 IP Devices With Multiple Ethernet Connection

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.5 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.

For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure that IP network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.

3.2.6 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

3.2.6.1 Default Requirements for Control System Devices

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: Devices using HTTP as a control protocol must use HTTPS instead.

3.2.7 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764.
For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification.

3.3.1.1 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface must at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface must at FULLY support user accounts.

e. For table entries of "KEY": The user interface must have physical security in the form of either a key lock on the interface itself or be furnished inside a locked enclosure. Where this is required for a read only interface, this lock must prevent viewing of data on the interface; for other interfaces, this lock must prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data that can be directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" must meet both the requirement indicated for X and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface must both MINIMALLY support accounts and have physical security.

h. Entries of the form "X or Y" must meet either the requirement indicated for X or the requirement indicated for Y.

3.3.1.1.1 Default Requirements for Other Control Systems

For control system devices where User Interface Requirements are not otherwise indicated in this Section, use the Default User Interface Requirements tables.

Default User Interface Requirements for MODERATE Impact Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	MINIMALLY
Local Limited, Privileged	MINIMALLY and Physical Security
Local Full	MINIMALLY and Physical Security
Remote Read Only	None Required
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY

Default User Interface Requirements for MODERATE Impact Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.2 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing must be configured as indicated.

3.3.1.2.1 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity.

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices must meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account accountafter five consecutive failed login attempts and must unlock the user account after 60 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when three unsuccessful logon attempts occur within a 15 minute interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for

1 hour and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network and have a local user interface must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels must be machine printed or engraved, plastic or metal, designed for permanent installation, must use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session Termination must result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this Section or display a publicly viewable image or blank screen. User Interfaces must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen. No interaction with the user interface must be possible until either a) the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must be terminated and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Controllers

Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after 30 minutes of inactivity.

Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must also support timed initiation of Session Termination, with Session Termination initiated at 30 minutes of inactivity.

3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions except read-only actions by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6 Physical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1 Physical Security for Media

3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.2 Physical Security for Devices

Install all devices which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the system, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

For MODERATE Impact Systems: Devices and software must not use cached authenticators.

3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.3 User Identification and Authentication for Specific Devices

There are no additional device specific user interface requirements

3.4.4 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.5 Password-Based Authentication Requirements

3.4.5.1 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts and supporting password-based authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.2 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.3 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of four characters.

3.4.5.4 Password Configuration and Reporting

For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.4.6 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

3.5 CYBERSECURITY AUDITING

3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-14(b), AU-14(1), AU-14(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-001230, CCI-000133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit

records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Default Requirements for Control System Controllers

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.1.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.1.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

f. All kernel module load, unload, and restart

g. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.1.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.1.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

The project site currently has the following software to support control system auditing: none. If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another Section, furnish the Auditing Front End Software media and license for subsequent Government installation. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other Sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to 2 seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For controllers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.

3.5.4.1 Device Audit Record Upload Software

For each device required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In case of an audit failure, if possible, continue to collect audit records by overwriting existing audit records.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the network communication report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

3.6.1 Device Capabilities

Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

For MODERATE Impact Systems: Do not provide (install) software that is not specifically required to meet a contract requirement. Do not implement functionality within software
that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-12, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For

MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Default Requirements for MODERATE Impact Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Mobile Code In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal.

For software provided and licensed to the Government under the requirements of another Section, submit a statement indicating the Section and Submittal under which the software was provided. For software provided to meet the requirements of this Section and not provided and licensed under another Section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit one hard copy of the software user manual for each piece of software.

3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSs) as a source of device power.

3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices must be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

3.11.1 Controllers

Provide controllers that are scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information must contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

Devices in the following systems which implement PIV must be on the NIST FIPS 201-2 approved product list (https://www.idmanagement.gov/approved-products-list/): NONE.

3.13 SYSTEM AND INTEGRATION INTEGRITY

3.13.1 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to CM-5(3); CCI-001749, CCI-002704, CCI-002726}

If there exists Integrity Verification Software that can check boot process, software,
firmware, or information in the control system and verify its integrity, provide it. If no such software exists provide a statement to this affect in lieu of the software.

3.14 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.14.1 Control System Cybersecurity Testing Procedures

Prepare Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section.

Submit 4 copies of the Control System Cybersecurity Testing Procedures. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.14.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this Section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.14.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results.

Submit four copies of the Control System Cybersecurity Testing Report. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package.

3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other Sections, provide a minimum of eight hours of technical support for cybersecurity

testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.16 CYBERSECURITY TRAINING

Provide eight hours of classroom and hands-on training for six Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.

The Government will provide the training location. Training must cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

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SECTION 25 05 11.05

CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - GENERATOR/SWITCHGEAR SCADA
05/21, CHG 1: 08/23

PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference only and enables coordination of the requirements of this Section with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

This Section refers to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs). STIGs and SRGs are available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/ and an SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this Section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this Section associated with this project. Different versions have requirements applicable to different control systems. This specific Section applies only to the following control systems: Generator / Switchgear SCADA (Secure ICS).

1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other Sections which specify control systems. This Section adds cybersecurity requirements to the control systems specified in other Sections, and as these requirements are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.

In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the Contracting Officer Representative to determine which requirement applies to the project.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.1x	(2010) Local and Metropolitan Area Networks - Port Based Network Access Control

INTERNET ENGINEERING TASK FORCE (IETF)

IETF RFC 2819	(2000) Remote Network Monitoring (RMON) Management Information Base (MIB)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST FIPS 140-2	(2001) Security Requirements for Cryptographic Modules
NIST FIPS 201-2	(2013) Personal Identity Verification (PIV) of Federal Employees and Contractors

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 8551.01	(2014) Ports, Protocols, and Services Management (PPSM)
DTM 08-060	(2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement

1.4 DEFINITIONS

1.4.1 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Administrator Account'.

1.4.2 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows

b. a device running a non-embedded version of MacOS

c. a device running a non-embedded version of Linux

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux

e. a device running a version of Apple iOS

Unless otherwise indicated or clear from context use of the word "device"

in this Section includes computers.

1.4.3 Controller

A device other than a computer or Ethernet switch.

1.4.4 Mission Space

A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a VAV box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an AHU in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.

1.4.5 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network.

1.4.6 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

1.4.6.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

1.4.7 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

1.4.8 User Account Support Levels

The support for user accounts is categorized in this Section as one of three levels:

1.4.8.1 FULLY Supported

Device supports configurable individual accounts. Accounts can be created, deleted, modified, etc. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

1.4.8.2 MINIMALLY Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which MINIMALLY support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configuration; and b) a room lighting control touchpad interface that has a single account.

1.4.8.3 NOT Supported

Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.

1.4.9 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.4.10 Card Reader

A card reader is an input/output device whose primary function is to assist in two-factor authentication. A card reader must have an interface to read data from a card and may be able to write data to a card. A card reader may have a means (such as buttons, keypad, touchscreen, etc.) for a user to input a PIN or password, as well as a limited display.

1.4.11 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate its user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the user interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter data, which is the "privilege" of the user interface (where effective

privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the user interface and the specific account the user is logged into).

1.4.11.1 Local User Interface

A Local User Interface is a user interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

1.4.11.2 Remote User Interface

A Remote User Interface implements a Client/Server model where the physical hardware the user interacts with (Client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the Client. The Client and Server communicate via a network connection. A common example of a remote user interface is a web-based interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a Client on the same hardware as the Server. What is important is that a) the Client may be on different hardware than the Server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

1.4.11.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.4.11.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.11.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of LIMITED UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.11.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Full Local User Interface while a browser-based front end is a Full Remote User Interface.

1.4.11.3.4 View-Only User Interface

See Read-Only User Interface

1.4.11.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.11.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.11.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Ultimately, whether a specific user interface is considered a Privileged User Interface must be determined by usage. Unless otherwise specified, user interfaces can be determined to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. Full User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allows for modification or deletion of audit logs are privileged user interface.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.12 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, 900 MHz radio, 2.4 GHz, free space optical, point-to-point laser, and IR.

1.4.13 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with The Contracting Office Representative (COR).

a. Government Computer Access Point of Contact: The Contracting Office Representative (COR)

b. HTTPS Certificate Point of Contact: The Contracting Office Representative (COR)

c. Password Point of Contact: The Contracting Office Representative (COR)

d. Mobile Code Point of Contact: The Contracting Office Representative (COR

1.5.2 Coordination

Coordinate the execution of this Section with the execution of all other Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

b. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

c. The Cybersecurity Interconnection Schedule must be coordinated with

other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.

d. Cybersecurity testing support must be coordinated across control systems and with the Government cybersecurity testing schedule.

e. Passwords must be coordinated with the indicated contact for the project site.

f. If applicable, HTTPS web server certificates must be obtained from the indicated HTTPS Certificate Point of Contact.

g. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Device Account Lock Exception Request; G, HNC

Multiple Ethernet Connection Device Request; G, HNC

Contractor Computer Cybersecurity Compliance Statements; G, HNC

Contractor Temporary Network Cybersecurity Compliance Statements; G, HNC

Cybersecurity Interconnection Schedule; G, HNC

Proposed STIG and SRG Applicability Report; G, HNC

Resumes and Certifications; G, HNC

SD-02 Shop Drawings

Network Communication Report; G, HNC

Cybersecurity Riser Diagram; G, HNC

SD-03 Product Data

Control System Cybersecurity Documentation; G, HNC

SD-06 Test Reports

Control System Cybersecurity Testing Procedures; G, HNC

Control System Cybersecurity Testing Report; G, HNC

SD-07 Certificates

Software Licenses; G, HNC

SD-11 Closeout Submittals

Confidential Password Report; G, RO

Enclosure Keys; G, RO

Software and Configuration Backups; G, HNC

Auditing Front End Software; G, HNC

Device Audit Record Upload Software; G, HNC

System Maintenance Tool Software; G, HNC

Control System Scanning Tools; G, HNC

STIG, SRG and Vendor Guide Compliance Result Report; G, HNC

Control System Inventory Report; G, HNC

Integrity Verification Software; G, HNC

1.6.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.7 QUALITY CONTROL

1.7.1 Qualifications

For the positions listed below, Resumes and Certifications shall be submitted to the Government within 14 days after notice to proceed. All certifications must be in effect prior to being hired.

These positons may serve across the contract.

1.7.1.1 Cybersecurity Subject Matter Expert

The individual will oversee all work within this specification and is responsible for verifying all submittals of the integrator and overseeing any system cybersecurity hardening. This position requires that the individual currently meets Information Assurance Manager Level II (IAM-II) Certification in accordance with DoDI 8570 Information Workforce Improvement Program and DoDI 8140 Cyberspace Workforce Improvement Program.

Individuals for this position should have experience securing DoD Systems and with the Risk Management Framework (RMF). Control System Experiece is required.

1.8 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.8.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model.

1.8.2 Cybersecurity Interconnection Schedule

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication. For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity Interconnection Schedule in Excel format is available at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1

1.8.3 Network Communication Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, including CM-7(3), CCI-000388.}

Provide a network communication report. For each networked device, document the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP, document all TCP and UDP ports used. For non-IP communications, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication Report as an editable Microsoft Excel file.

1.8.4 Control System Inventory Report

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Provide a Control System Inventory report using the Inventory Spreadsheet listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 documenting all devices, including networked devices, network infrastructure devices, non-networked devices, input devices (e.g. sensors) and output devices (e.g. actuators). For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Report as an editable Microsoft Excel file.

1.8.5 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For each computer on which software is installed under this project, provide a recovery image of the final as-built computer. This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software. If additional user permissions are required to meet this requirement, coordinate the creation of the image with the identified Government Computer Access Point of Contact. For all ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software that is not common to every controller of the same manufacturer and model).

If any or all of these are provided under another Section, provide documentation indicating this and referencing those submittals.

1.8.6 Cybersecurity Riser Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity riser diagram of the complete control system including all network and device hardware. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in one-line format.

1.8.7 STIG, SRG and Vendor Guide Compliance Result Report

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, provide a result report documenting compliance with the STIG or SRG requirements. For components which are scannable by the SCAP (security content automation protocol) tool (available online at https://public.cyber.mil/stigs/scap), provide the SCAP report and raw scan results.

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.8.8 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5(a),SA-5(b),SA-5(c), SA-22(b); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131, CCI-003374}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.8.8.1 Software Applications

For all software applications running on computers provide:

a. administrator documentation that describes secure configuration of the software {For Government Reference Only: relates to CCI-003124}

b. administrator documentation that describes secure installation of the software and software updates. {For Government Reference Only: relates to CCI-003125}

c. administrator documentation that describes secure operation of the software {For Government Reference Only: relates to CCI-003124}

d. administrator documentation that describes effective use and maintenance of security functions or mechanisms for the software {For Government Reference Only: relates to CCI-003127}

e. administrator documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the software {For Government Reference Only: relates to CCI-003128}

f. user documentation that describes user-accessible security functions or mechanisms in the software and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. user documentation that describes methods for user interaction which enables individuals to use the software in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. user documentation that describes user responsibilities in maintaining the security of the software {For Government Reference Only: relates to CCI-003131}

1.8.8.2 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

i. Documentation of the published last date of support by the manufacturer or indication that a published date is not available. {For Government Reference Only: relates to CCI-003374}

1.9 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the project site for a period of no less than 5 years, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided

1.10 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, CA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet following requirement throughout the construction process.

1.10.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.10.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must be scanned using the installed software at least once per day.

1.10.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.10.1.5 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.10.1.6 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company.

1.10.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.10.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.10.3 Government Access to Network

Government personnel must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.10.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.

1.10.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.10.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.11 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

All products used on this project must meet the indicated requirements, but not all products specified here will be required by every project.

2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

2.1.1 Required Functionality

Switches must:

a. Copper Ethernet ports must auto negotiate for 10, 100 and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address and limit the number of MAC addresses to one MAC address per port.

c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819

e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.

f. Support authentication via RADIUS server (for management and 802.1x)

g. Support IEEE 802.1x network login.

2.1.2 Configuration Requirements

Switches must:

a. Support configuration save and restore.

b. Support both manual IP address assignment and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.

d. Support the ability to lock configuration capability to a dedicated management port.

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

{For Government Reference Only: This subpart (and its subparts) relate to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906}

All computer-based databases must use Microsoft SQL Server or Oracle or MySQL. All computer-based web interfaces must use Internet Information Services (IIS) or Apache as the web server.

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with required functionality or another requirement of this Section.

3.2 NETWORK REQUIREMENTS

3.2.1 Information Flow Enforcement In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

3.2.2 Wireless and Wired Broadcast Communication

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-001449}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication.

3.2.3 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.4 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of

non-IP networks.

3.2.4.1 IP Network Routers

Do not install any device that performs IP routing.

3.2.4.2 IP Devices With Multiple Ethernet Connection

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-1 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.5 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.

For devices that have STIG/SRGs related to cryptographic protection (CCI-002450), comply with the requirements of those STIG/SRGs. Ensure that IP network traffic is encrypted using NSA-approved cryptography; provision of digital signatures and hashing, and FIPS-validated cryptography.

3.2.6 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

All computers must support IEEE 802.1x for device authentication to the network.

3.2.6.1 Default Requirements for Control System Devices

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: Devices using HTTP as a control protocol must use HTTPS instead.

3.2.7 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764.
For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification.

3.3.1.1 Computers

All computer operating systems must FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer must be installed such that use of the software is restricted by the computer operating system to specific users.

Applications running on computers must not require the user be logged in to a computer operating system administrator account for normal operation. It is permissible to require the computer operating system administrator account for initial application installation and configuration.

3.3.1.2 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface must at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface must at FULLY support user accounts.

e. For table entries of "KEY": The user interface must have physical

security in the form of either a key lock on the interface itself or be furnished inside a locked enclosure. Where this is required for a read only interface, this lock must prevent viewing of data on the interface; for other interfaces, this lock must prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data that can be directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" must meet both the requirement indicated for X and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface must both MINIMALLY support accounts and have physical security.

h. Entries of the form "X or Y" must meet either the requirement indicated for X or the requirement indicated for Y.

3.3.1.2.1 Default Requirements for Other Control Systems

For control system devices where User Interface Requirements are not otherwise indicated in this Section, use the Default User Interface Requirements tables.

Default User Interface Requirements for MODERATE Impact Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	MINIMALLY
Local Limited, Privileged	MINIMALLY and Physical Security
Local Full	MINIMALLY and Physical Security
Remote Read Only	None Required
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full (see note 2)	FULLY

Default User Interface Requirements for MODERATE Impact Control Systems	
User Interface Type	**Access Control Requirement** (See note 3)
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged 3)Devices outside mission space require physical security protections as indicated (in "PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS")	

3.3.1.3 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing must be configured as indicated.

3.3.1.3.1 For Control System Applications Running on Computers

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 35 days of inactivity.

3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity.

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices must meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account accountafter five consecutive failed login attempts and must unlock the user account after 60 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when three unsuccessful logon attempts

occur within a 15 minute interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for 1 hour and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

There are no high availability interfaces which are exempt from unsuccessful logon attempts requirements.

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network and have a local user interface must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels must be machine printed or engraved, plastic or metal, designed for permanent installation, must use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session Termination must result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this Section

or display a publicly viewable image or blank screen. User Interfaces must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen. No interaction with the user interface must be possible until either a) the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must be terminated and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Computers

User Interface sessions provided by computer operating systems must support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination must be capable of being initiated by the user and must also be initiated by lack of activity. Session Lock must occur after 15 minutes of inactivity, and Session Termination must occur after 30 minutes total of inactivity (including, not in addition to, the time for Session Lock). When a user initiates a new session, terminate existing sessions if necessary to limit the total number of concurrent sessions to 1.

Other User Interface sessions running on computers (for local user interfaces) or hosted on a computer (for remote user interfaces) and supporting accounts must support user initiation of Session Termination and session lock. Session lock may be initiated by user initiation or automatically after 15 minutes of inactivity. In addition, remote User Interface sessions must also initiate Session Termination after 30 minutes of inactivity .

3.3.4.4 Session Lock and Termination for Controllers

Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after 30 minutes of inactivity.

Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must also support timed initiation of Session Termination, with Session Termination initiated at 30 minutes of inactivity.

3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before

allowing any actions except read-only actions by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6 Physical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1 Physical Security for Media

3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.2 Physical Security for Devices

Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the system, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

For MODERATE Impact Systems: Software running on computers and computer operating systems must manage cached authenticators in accordance with the relevant STIGs. All other devices and software must not use cached authenticators.

3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.3 User Identification and Authentication for Specific Devices

There are no additional device specific user interface requirements

3.4.4 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.5 Password-Based Authentication Requirements

3.4.5.1 Passwords for Software and Applications Running on Computers

All software and applications running on computers supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of

supported special characters must include at least 4 separate characters.

f. Password must have a minimum lifetime of 24 hours.

g. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

h. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

i. Passwords must be cryptographically protected during storage and transmission.

3.4.5.2 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts and supporting password-based authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five (5) passwords, where differ is defined as changing at least fifty percent of the characters.

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.3 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication must enforce the following requirements:

a. Minimum password length of twelve (12) characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate

characters.

f. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.4 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of four characters.

3.4.5.5 Password Configuration and Reporting

For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.4.6 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

3.5 CYBERSECURITY AUDITING

3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-14(b), AU-14(1), AU-14(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-001230, CCI-000133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Computers

For each computer, provide the capability to select audited events and the content of audit logs. Configure computers to audit the indicated events, and to record the indicated information for each auditable event

3.5.1.1.1 Audited Events

Configure each computer to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Privileged activities or other system level access

e. Concurrent logons from different workstations

f. Successful and unsuccessful accesses to objects

g. All program initiations

h. All direct access to the information system

i. All account creations, modifications, disabling, and terminations.

j. All kernel module load, unload, and restart

3.5.1.1.2 Audit Event Information To Record

Configure each computer to record, for each auditable event, the following information (where applicable to the event):

a. What type of event occurred

b. When the event occurred

c. Where the event occurred

d. The source of the event

e. The outcome of the event

f. The identity of any individuals or subjects associated with the event

h. For MODERATE Impact Systems: For all privileged commands, full-text recording of the executed command and the user executing the command

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of

damage, malfunction, or security violation.

3.5.1.2 Default Requirements for Control System Controllers

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.2.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.2.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

f. All kernel module load, unload, and restart

g. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.2.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of

damage, malfunction, or security violation

3.5.1.2.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device (computer or controller) generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device (computer or controller) generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

The project site currently has the following software to support control system auditing: none. If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another Section, furnish the Auditing Front End Software media and license the control system front end computer . Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other Sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881,

CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to 2 seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For controllers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.
c. For computers, provide storage for at least 60 days worth of audit records, assuming 200 auditable events per day.

3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-5(1); CCI-001855.}

Computers storing audit logs must provide notification when audit logs reach 75 percent of capacity.

3.5.4.2 Device Audit Record Upload Software

For each device required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

When Device Audit Record Upload Software is capable of uploading audit logs over the network, install Device Audit Record Upload Software on the same computer as the Auditing Front End Software. Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In case of an audit failure, if possible, continue to collect audit records by overwriting existing audit records.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the network communication report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

3.6.1 Device Capabilities

Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

For MODERATE Impact Systems: Do not provide (install) software that is not specifically required to meet a contract requirement. Do not implement functionality within software
that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-12, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Default Requirements for MODERATE Impact Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Mobile Code In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b), SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software with the software submittal.

For software provided and licensed to the Government under the requirements of another Section, submit a statement indicating the Section and Submittal under which the software was provided. For software provided to meet the requirements of this Section and not provided and licensed under another Section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit one hard copy of the software user manual for each piece of software.

3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSs) as a source of device power.

3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices must be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

3.11.1 Computers and Software Running on Computers

Computers and applications running on computers must meet relevant vulnerability scanning STIGs/SRGs and respond to approved DoD vulnerability scanning tools.

3.11.2 Controllers

Provide controllers that are scannable by standard control system

discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information must contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.12 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

Devices in the following systems which implement PIV must be on the NIST FIPS 201-2 approved product list (https://www.idmanagement.gov/approved-products-list/): NONE.

3.13 SYSTEM AND INTEGRATION INTEGRITY

3.13.1 Malicious Code Protection

{For Government Reference Only: This subpart (and its subparts) relates to SI-3(c); CCI-001241, CCI-002623}

For all computers installed under this project, provide malware protection software media, provide licenses, and install and configure malware protection software as indicated. Coordinate with the Government Computer Access Point of Contact as required.

a. Provide malware protection software licenses.

b. Provide malware protection software media.

c. Install and configure malware protection software in accordance with the relevant STIGs.

3.13.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to CM-5(3); CCI-001749, CCI-002704, CCI-002726}

If there exists Integrity Verification Software that can check boot process, software, firmware, or information in the control system and verify its integrity, provide it. If no such software exists provide a statement to this affect in lieu of the software.

3.14 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.14.1 Control System Cybersecurity Testing Procedures

Prepare Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section.

Submit 4 copies of the Control System Cybersecurity Testing Procedures. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.14.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this Section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.14.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results.

Submit four copies of the Control System Cybersecurity Testing Report. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package.

3.15 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other Sections, provide a minimum of sixteen hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.16 CYBERSECURITY TRAINING

Provide sixteen hours of classroom and hands-on training for six Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.

The Government will provide the training location. Training must cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

-- End of Section --

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SECTION 25 08 10

UTILITY MONITORING AND CONTROL SYSTEM TESTING

05/21

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SECTION 25 08 10

UTILITY MONITORING AND CONTROL SYSTEM TESTING
05/21

PART 1 GENERAL

1.1 DEFINITIONS

In addition to the definitions provided in this Section, 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION contain definitions related to this Section.

1.1.1 Algorithm

A set of well-defined rules or procedures for solving a problem or providing an output from a specific set of inputs.

1.1.2 Analog

A signal that can take on continuous (as opposed to discrete) values. Sensors (e.g. temperature, pressure, flow) typically provide analog signals as outputs to represent the measured variable. Within the UMCS, analog signals are generally represented by either 0-10 volt or a 4-20 milliamp signal.

1.1.3 Binary

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level.

1.1.4 Change-Of-Value (COV)

A type of data transmission over the network where the point value is transmitted over the network only when its value changes. COV is an efficient use of network bandwidth.

1.1.5 Control Wiring

This includes conduit, wire, and wiring devices to install complete HVAC control systems, including motor control circuits, interlocks, sensors, PE and EP switches, and like devices. This also includes all wiring from node to node, and nodes to all sensors and points defined in the I/O summary shown on drawings or specified herein, and required to execute the sequence of operation. Does not include line voltage power wiring.

1.1.6 Demand

The maximum rate of use of electrical energy averaged over a specific interval of time, usually expressed in kW.

1.1.7 Graphical User Interface (GUI)

Human-machine interfacing allows the operator to manage, command, monitor, and program the system.

1.1.8 Integration

Establishing communication between two or more systems to create a single system.

1.1.9 Protocol

In control systems, "protocol" is generally shorthand for "communication protocol"; a defined method by which digital information is exchanged electronically. Often more than one protocol is used in a BAS, for example, a typical BACnet system will use at a minimum (in addition to BACnet/IP and BACnet MS/TP) IP, UDP, ARP, Ethernet, and RS-485 protocols (and this does not include any protocols used internally in the front end or for communication with front end client workstations).

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Sequencing

Performance Verification Testing required by this Section must be proceeded by successful and accepted "contractors field testing" or "start-up and start-up testing" of the control system to be tested.

1.2.2 Scheduling

Coordinate testing schedules with the Government and with work in other Sections performed on the components or systems to be tested.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

PVT Plan; G, RO

PVT Phase I Report; G, RO

PVT Phase II Report; G, RO

SD-07 Certificates

Test Instrumentation Calibration Certificates; G, RO

1.4 TEST EQUIPMENT

Provide all test equipment unless otherwise noted in the contract documents. Use only test equipment with current calibration traceable to the National Institute of Science and Technology (NIST). For each test instrument, submit Test Instrumentation Calibration Certificates demonstrating calibration traceable to NIST. Use test equipment and test methods such that the overall accuracy of the test method, including all test instrumentation and any errors inherent in the test procedure, is at least 50 percent better than the accuracy specified for the sensor. For example, if a temperature sensor has an accuracy requirement of plus or minus 1 degree Farenheit degree overall accuracy of the test method, must

be 0.5 degree Farenheit or better.

When validating sensor accuracy, the test instrument is treated as if it is perfectly accurate; that is, the measured value from the test instrument must lie within the bounds of the specified accuracy of the sensor. Expressed mathematically:

Given:
Sensor accuracy: Plus or minus X
Sensor reading: Y
Test equipment reading: Z
Where X, Y and Z are real numberts.

Then
Sensor passes if: (Y-X) <= Z <= (Y+X)
otherwise, sensor fails

PART 2 PRODUCTS

Not applicable

PART 3 EXECUTION

3.1 PERFORMANCE VERIFICATION TEST (PVT)

Perform a Performance Verification Test (PVT) to demonstrate that the installed control system meets all requirements of the project specifications. Coordinate scheduling of the PVT with the Government, and do not begin the PVT until the PVT Plan submittal is accepted.

3.1.1 PVT PLAN

Provide a PVT Plan including system documentation and PVT Procedures.

3.1.1.1 PVT Plan System Documentation

Include the following system documentation in the PVT Plan:

a. Copies of the most recent as-built drawings for the system, including but not limited to one-line drawings and Points Schedules as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC showing device address, point descriptions, network point names and types, hardware point types, settings and ranges including units.

b. Copies of manufacturer's product data sheets when needed to demonstrate compliance with project requirements. In particular, provide data sheets showing that surge protection requirements have been met.

c. Operation or user manuals for all software and all DDC Hardware to be tested.

d. List of test equipment.

3.1.1.2 PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment include manufacturer name, model number, equipment function, the date of the latest

calibration, and the results of the latest calibration

3.1.1.3 PVT Procedures

Develop PVT procedures using the test procedures in this Section, modifying the procedures and adding tests as appropriate to develop procedures that test all requirements of the project specifications. The test procedures must consist of detailed instructions for test setup, execution, and evaluation of test results.

When developing additional procedures, provide the same information and fields as shown in the Test Template.

3.1.2 PVT Phases

Conduct PVT testing in two phases:

I. Field testing for devices, components, subsystems and the overall system using the approved PVT Procedures.

II. A one-week endurance test during which the system is operated continuously.

3.1.2.1 PVT Phase I (Field Tests)

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems fully and correctly implement the sequences of operation. PVT for surge protection is not required to include introducing a surge to the equipment; surge protection may instead be demonstrated through product documentation.

Do not start the performance verification test until after receipt of written permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing of the HVAC System. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. At the completion PVT Phase I and in accordance with the project schedule and project sequencing provide a PVT Phase I Report documenting all PVT testing including all approved test procedures with test results indicated on the procedures, and a record of all actions taken to address PVT test failures.

3.1.2.2 PVT Phase II (Endurance Test)

Complete an endurance test as part of the PVT in which the system is operated contuinuously for one-week without failure. During the endurance test trend all points shown as requiring a trend on the Points Schedule for the entire duration of the endurance test. If insufficient buffer or storage capacity exists to trend the entire endurance test, offload trend logs during the course of the endurance test to ensure that no trend data is lost. If the control system specification includes bandwidth requirements for bandwidth usage on a non-IP network, measure and record the network bandwidth usage on each non-IP channel during the endurance test.

If the system experiences any failures during the endurance test portion of the PVT, repair the system and repeat the endurance test portion of the

PVT until the system operates continuously and without failure for the specified endurance test period. At the completion of PVT Phase II and in accordance with the project schedule and project sequencing provide a PVT Phase II Report documenting failures and repair actions taken during PVT Phase II.

3.1.2.2.1 Temporary Trending Capability

Unless trending capability exists, either within the building control system or through a connected Utility Monitoring and Control System (UMCS) Front End, temporarily install hardware on the building control network to perform trending during the endurance test as indicated. Remove the temporary hardware at the completion of all testing and commissioning activities.

3.2 FACTORY TEST

Perform a Factory Test to demonstrate the capability of the proposed control system solution to meet the requirements of project specifications. Coordinate scheduling of the Factory Test with the Government, and do not begin the Factory Test unil the Factory Test Plan submittal is accepted.

3.2.1 Factory Test Setup

Design the Factory Test Setup to represent the system as it will be fielded and to demonstrate the capability of the system to meet the requirements of the project specification. At a minimum:

a. Include at least one of each model of DDC hardware, instrumentation and control device to be used on the project.

b. Include at least one network of each type to bue used on the project.

c. Include a programmable controller programmed as it will be installed, or, if no programmable controller is to be installed on the project, include a programmable controller with a sample application.

d. Include sample hardware to provide a mock field control system for the front end to communicate with if the project requires a front end but does not require a field control system.

3.2.2 Factory Test Plan

Provide a Factory Test Plan documenting the test setup and procedures.

3.2.2.1 Factory Test Plan Setup Documentation

Include the following information, at a minimum, to document the factory test setup:

a. System one-line block diagram of equipment used in the factory test identifying computers (servers and workstations), network hardware, DDC hardware, and other instrumentation including, but not limited to, sensors, actuators, test signal generators, and meters.

b. System hardware description used in the factory test.

c. System software description used in the factory test.

d. Points Schedules for each controller showing the configuration to be used during the test. Points Schedules must include the following information at a minimum: device address, point descriptions, network point names and types, hardware point types, settings and ranges including units.

e. Required passwords for each operator access level.

f. List of other test equipment.

3.2.2.2 Test Procedures

Develop factory test procedures using the Test Procedures in this Section, modifying the procedures and adding tests as appropriate to develop test procedures that test all requirements of the specification. The test procedures must consist of detailed instructions for test setup, execution, and evaluation of test results. Factory test procedures must include testing of surge protection by introducing a surge to the equipment and demonstrating that the equipment survives.

When developing additional procedures, provide the same information and fields as shown in the Test Template.

3.2.3 Factory Test Report

Upon completion of the Factory Test provide a complete test report, consisting of a short summary of the factory test, a copy of the Factory Test Plan, and copies of the executed test procedures separated by test. For each test, include date performed and identify the Government representative who witnessed and approved the test.

If a portion of any test failed, document the failure and corrective action.

3.2.4 Fatory Test Execution

Conduct the Factory Test at a location and time approved by the Government. The Government will witness the factory test.

If the system fails a portion of a test, the Government will determine whether the entire test or only the portion that failed must be repeated.

3.3 TEST PROCEDURES

Develop test procedures using the template procedure in the Appendix. A test template and sample test procedures in electronic format are available at the Whole Building Design Guide page for this section: https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-08-1 Refer to the Sample Test Procedures Table to view the existing sample tests.

Sample Test Procedures	
Test No.	Test Title
1	System Equipment Verification
2	System Start-up
3	Monitoring and Control (M&C) Software Passwords
4	Graphic Display of Data
5	Graphic Navigation Scheme
6	Command Functions
7	Command Input Errors
8	Special Functions
9	Software Editing Tools
10	Scheduling
11	Alarm function
12	Trending
13	Demand Limiting
14	Report Generation
15	Uninterruptable Power Supply (UPS) Test
16	Routers and Repeaters
17	Gateways (Building Level)
18	Gateways (Device Level)
19	Local Display Panel (LDP)
20	Open Network Point Verification
21	Custom Test Template

APPENDIX A
TEST NUMBER: <TEST NUMBER>
TEST TITLE: <TEST TITLE>

OBJECTIVE: <STATE TEST OBJECTIVE>

INITIAL REQUIREMENTS/CONDITIONS

1. Submittals: <LIST REQUIRED SUBMITTALS>

2. Equipment: <LIST EQUIPMENT REQUIRED FOR TEST>

3. Reference Documentation: <LIST REQUIRED REFERENCE DOCUMENTATION>

Date of Test: _____
Time of Test: _____
Contractor's Representative: _____
Government's Representative: _____

Specification References for this verification:
<LIST SECTIONS REFERENCED FOR THIS TEST>

TEST PROCEDURES: <USE THE FOLLOWING FORMAT FOR TEST PROCEDURES, EXPAND AS NECESSARY TO CAPTURE ALL TEST ITEMS>

Item	Action	Expected Results	Approved
1			
2			
3			
4			

Item	Action	Expected Results	Approved
Notes:			

-- End of Section --

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DIVISION 25 - INTEGRATED AUTOMATION

SECTION 25 10 10

UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION

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SECTION 25 10 10

UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION
02/19, CHG 1: 05/21

PART 1 GENERAL

1.1 SUMMARY

Integrate field control systems installed per Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS to the UMCS via Niagara Framework Supervisory Gateways as specified.

1.1.1 Symbols, Definition and Abbreviations

Use symbols, definitions, and engineering unit abbreviations indicated in the contract drawings for displays, submittals and reports. For symbols, definitions and abbreviations not in the contract drawings use terms conforming at a minimum to IEEE Stds Dictionary and the ASHRAE FUN IP, as applicable.

1.2 RELATED SECTIONS

Cybersecurity requirements related to this Section are specified in a separate cybersecurity specification derived from UFGS 25 05 11. Section 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC specifies cybersecurity requirements related to this Section.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks
ASHRAE FUN IP	(2021) Fundamentals Handbook, I-P Edition

CONSUMER ELECTRONICS ASSOCIATION (CEA)

CEA-709.1-D	(2014) Control Network Protocol Specification
CEA-709.3	(1999; R 2015) Free-Topology Twisted-Pair Channel Specification
CEA-852-C	(2014) Tunneling Device Area Network

Protocols Over Internet Protocol Channels

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

LONMARK INTERNATIONAL (LonMark)

LonMark Interoperability Guide	(2005) LonMark Application-Layer Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4

MODBUS ORGANIZATION, INC (MODBUS)

MODBUS Protocol	(2012) Modbus Application Protocol Specification; Version 1.1b3
MODBUS TCP/IP	(2006) Modbus Messaging on TCP/IP Implementation Guide; Version V1.0b

OPC FOUNDATION (OPC)

OPC DA	(Ver 3.0; Errata) OPC Data Access (DA)

1.4 DEFINITIONS

The following list of definitions may contain terms not found elsewhere in this Section but are included here for completeness. Some terms are followed with a protocol reference in parenthesis indicating to which protocol the term and definition applies. Inclusion of protocol-specific definitions does not create a requirement to support that protocol, nor does it relax any requirements to support specific protocols as indicated elsewhere in this section.

1.4.1 Alarm Generation

The process of comparing a point value (the point being alarmed) with a pre-defined alarm condition (e.g. a High Limit) and performing some action based on the result of the comparison.

1.4.2 Alarm Handling

see Alarm Routing

1.4.3 Alarm Routing

Alarm routing is M&C software functionality that starts with a notification that an alarm exists (typically as the output of an Alarm Generation process) and sends a specific message to a specific alarm recipient or device.

1.4.4 Application Generic Controller (AGC)(LonWorks)

A device that is furnished with a (limited) pre-established application that also has the capability of being programmed. Further, the ProgramID and XIF file of the device are fixed. The programming capability of an AGC may be less flexible than that of a General Purpose Programmable Controller (GPPC).

1.4.5 Application Specific Controller (ASC)(LonWorks)

A device that is furnished with a pre-established built in application that is configurable but not re-programmable. An ASC has a fixed factory-installed application program (i.e Program ID) with configurable settings.

1.4.6 BACnet (BACnet)

The term BACnet is used in two ways. First meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. The second to refer to the overall technology related to the ASHRAE 135 protocol.

1.4.7 BACnet Advanced Application Controller (B-AAC)(BACnet)

A hardware device BTL Listed as a B-AAC. A control device which contains BIBBs in support of scheduling and alarming but otherwise has limited resources relative to a B-BC. It may be intended for specific applications and supports some degree of programmability.

1.4.8 BACnet Advanced Operator Workstation (B-AWS)(BACnet)

Monitoring and Control (M&C) Software BTL Listed as an Advanced Operator Workstation and includes the ability to manage scheduling, alarming and trending in an open manner. The B-AWS is the advanced operator's window into a BACnet system. It is primarily used to monitor the performance of a system and to modify parameters that affect the operation of a system.

1.4.9 BACnet Application Specific Controller (B-ASC)(BACnet)

A hardware device BTL Listed as a B-ASC. A controller with limited resources relative to a B-AAC. It is intended for use in a specific application and supports limited programmability.

1.4.10 BACnet Building Controller (B-BC)(BACnet)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

1.4.11 BACnet Internetwork (BACnet)

Two or more BACnet networks connected with BACnet routers. In a BACnet Internetwork, there exists only one message path between devices.

1.4.12 BACnet Interoperability Building Blocks (BIBBs) (BACnet)

A BIBB is a collection of one or more BACnet services intended to define a

higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by an M&C client, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

1.4.13 BACnet Operator Display (B-OD)(BACnet)

A hardware device BTL Listed as a B-OD. A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. The B-OD profile could be used for wall-mounted LCD devices, displays affixed to BACnet devices; hand-held terminals or other very simple user interfaces.

1.4.14 BACnet Operator Workstation (B-OWS)(BACnet)

Monitoring and Control (M&C) Software BTL Listed as a B-OWS. An operator interface with limited capabilities relative to a B-AWS. The B-OWS is used for monitoring and basic control of a system, but differs from a B-AWS in that it does not support configuration activities, nor does it provide advanced troubleshooting capabilities.

1.4.15 BACnet Smart Actuator (B-SA)(BACnet)

A hardware device BTL Listed as a B-SA. A simple control output device with limited resources; it is intended for specific applications.

1.4.16 BACnet Smart Sensor (B-SS)(BACnet)

A hardware device BTL Listed as a B-SS. A simple sensing device with very limited resources.

1.4.17 BACnet Testing Laboratories (BTL)(BACnet)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

1.4.18 BACnet Testing Laboratories (BTL) Listed (BACnet)

A device that has been certified by BACnet® Testing Laboratory. Devices may be certified to a specific device profile, in which case the certification indicates that the device supports the required capabilities for that profile, or may be certified as "other".

1.4.19 Binary

A two-state system or signal; for example one where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

1.4.20 Binding (LonWorks)

The act of establishing communications between CEA-709.1-D devices by associating the output of a device to the input of another so that

information is automatically (and regularly) sent without being requested by the recipient.

1.4.21 Broadcast

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

1.4.22 Building Control Network (BCN)

The network used by the Building Control System. Typically the BCN is a BACnet ASHRAE 135 or LonWorks CEA-709.1-D network installed by the building control system contractor.

1.4.23 Building Control System (BCS)

One type of Field Control System. A control system for building electrical and mechanical systems, typically HVAC (including central plants) and lighting. A BCS generally uses Direct Digital Control (DDC) Hardware and generally does NOT include its own local front end.

1.4.24 Building Point of Connection (BPOC)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware)

1.4.25 Channel (LonWorks)

A portion of the control network consisting of one or more segments connected by repeaters. Channels are separated by routers. The device quantity limitation is dependent on the topology/media and device type. For example, a TP/FT-10 network with locally powered devices is limited to 128 devices per channel.

1.4.26 Commandable (BACnet)

A point (Object) is commandable if its Present_Value Property is writable and it supports the optional Priority_Array Property. This functionality is useful for Overrides.

1.4.27 Configuration Property (LonWorks)

Controller parameter used by the application which is usually set during installation/testing and seldom changed. For example, the P and I settings of a P-I control loop. Also see 'Standard Configuration Property Type (SCPT)'

1.4.28 Control Logic Diagram

A graphical representation of control logic for multiple processes that make up a system.

1.4.29 Device Object (BACnet)

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object

requires a unique Object_Identifier number on the BACnet Internetwork. This number is often referred to as the device instance or device ID.

1.4.30 Explicit Messaging (LonWorks)

A non-standard and often vendor (application) specific method of communication between devices.

1.4.31 External Interface File (XIF) (LonWorks)

A file which documents a device's external interface, specifically the number and types of LonMark objects, the number, types, directions, and connection attributes of network variables, and the number of message tags.

1.4.32 Field Point Of Connection (FPOC)

The FPOC is part of the UMCS IP network and acts as the point of connection between the UMCS IP Network and the field control IP network. The FPOC is an IT device such as a switch, IP router, or firewall, typically managed by the site IT staff. (Note that the field control IP network may consist of a single IP device, or that integration may require installation of a field control network IP device.)

1.4.33 Field Control Network

The network used by a field control system.

1.4.34 Field Control System (FCS)

A building control system or utility control system.

1.4.35 Fox Protocol (Niagara Framework)

The protocol used for communication between components in the Niagara Framework. By default, Fox uses TCP port 1911

1.4.36 Functional Profile (LonWorks)

A standard description, defined by LonMark International, of a LonMark Object used to classify and certify devices.

1.4.37 Gateway

A device that translates from one protocol to another. Devices that change only the transport mechanism of the protocol - "translating" from LonWorks over TP/FT-10 to LonWorks over IP for example - are not gateways as the underlying protocol (data format) does not change. Gateways are also called Communications Bridges or Protocol Translators.

1.4.38 General Purpose Programmable Controller (GPPC) (LonWorks)

Unlike an ASC or AGC, a GPPC is not furnished with a fixed application program and does not have a fixed ProgramID or XIF file. A GPPC can be (re-)programmed, usually using vendor-supplied software. When a change to the program affects the external interface (and the XIF file) the ProgramID will change.

1.4.39 Internetwork (BACnet)

See BACnet Internetwork.

1.4.40 JACE (Niagara Framework)

Java Application Control Engine. See Niagara Framework Supervisory Gateway

1.4.41 LonMark Object (LonWorks)

A collection of network variables, configuration properties, and associated behavior defined by LonMark International and described by a Functional Profile. It defines how information is exchanged between devices on a network (inputs from and outputs to the network).

1.4.42 LNS Plug-in (LonWorks)

Software which runs in an LNS compatible software tool, typically a network configuration tool. Device configuration plug-ins provide a 'user friendly' method to edit a device's configuration properties.

1.4.43 LonMark (LonWorks)

See LonMark International. Also, a certification issued by LonMark International to CEA-709.1-D devices.

1.4.44 LonMark International (LonWorks)

Standards committee consisting of independent product developers, system integrators and end users dedicated to determining and maintaining the interoperability guidelines for LonWorks. Maintains guidelines for the interoperability of CEA-709.1-D devices and issues the LonMark Certification for CEA-709.1-D devices.

1.4.45 LonWorks (LonWorks)

The term used to refer to the overall technology related to the CEA-709.1-D protocol (sometimes called "LonTalk"), including the protocol itself, network management, interoperability guidelines and products.

1.4.46 LonWorks Network Services (LNS) (LonWorks)

A network management and database standard for CEA-709.1-D devices.

1.4.47 LonWorks Network Services (LNS) Database (LonWorks)

The standard database created and used by LonWorks Network Services (LNS) compatible tools, such as LNS Network Configuration tools.

1.4.48 Modbus

A basic protocol for control network communications generally used in utility control systems. The Modbus protocol standard is maintained by The Modbus Organization.

1.4.49 Master-Slave/Token Passing (MS/TP)(BACnet)

Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.

1.4.50 Monitoring and Control (M&C) Software

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

1.4.51 Network (BACnet)

In BACnet, a portion of the control internetwork consisting of one or more segments of the same media connected by repeaters. Networks are separated by routers.

1.4.52 Network Variable (LonWorks)

See 'Standard Network Variable Type (SNVT)'.

1.4.53 Network Configuration Tool (LonWorks)

The software used to configure the control network and set device configuration properties. This software creates and modifies the control network database (LNS Database).

1.4.54 Niagara Framework

A set of hardware and software specifications for building and utility control owned by Tridium Inc. and licensed to multiple vendors. The Framework consists of front end (M&C) software, web based clients, field level control hardware, and engineering tools. While the Niagara Framework is not adopted by a recognized standards body and does not use an open licensing model, it is sufficiently well-supported by multiple HVAC vendors to be considered a de-facto Open Standard.

1.4.55 Niagara Framework Supervisory Gateway (Niagara Framework)

DDC Hardware component of the Niagara Framework. A typical Niagara architecture has Niagara specific supervisory gateways at the IP level and other (non-Niagara specific) controllers on field networks (TP/FT-10, MS/TP, etc.) beneath the Niagara supervisory gateways. The Niagara specific controllers function as a gateway between the Niagara framework protocol (Fox) and the field network beneath. These supervisory gateways may also be used as general purpose controllers and also have the capability to provide a web-browser based user interface.

Note that different vendors refer to this component by different names. The most common name is "JACE"; other names include "EC-BOS", "FX-40", and "UNC".

1.4.56 Node (LonWorks)

A device that communicates using the CEA-709.1-D protocol and is connected to a CEA-709.1-D network.

1.4.57 Node Address (LonWorks)

The logical address of a node on the network, consisting of a Domain number, Subnet number and Node number. Note that the "Node number" portion of the address is the number assigned to the device during installation and is unique within a subnet. This is not the factory-set

unique Node ID (see Node ID).

1.4.58 Node ID (LonWorks)

A unique 48-bit identifier assigned (at the factory) to each CEA-709.1-D device. Sometimes called the Neuron ID.

1.4.59 Object (BACnet)

A BACnet Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

1.4.60 Override

To change the value of a point outside of the normal sequence of operation where this change has priority over the sequence. An override can be accomplished in one of two ways: the point itself may be Commandable and written to with a priority or there may be a separate point on the controller for the express purpose of implementing the override.

Typically this override is from the Utility Monitoring and Control System (UMCS) Monitoring and Control (M&C) Software. Note that this definition is not standard throughout industry.

1.4.61 Point, Calculated

A value within the M&C Software that is not a network point but has been calculated by logic within the software based on the value of network points or other calculated points. Calculated points are sometimes called virtual points or internal points.

1.4.62 Point, Network

A value that the M&C Software reads from or writes to a field control network.

1.4.63 Polling

A requested transmission of data between devices, rather than an unrequested transmission such as Change-Of-Value (COV) or Binding where data is automatically transmitted under certain conditions.

1.4.64 Program ID (LonWorks)

An identifier (number) stored in the device (usually EEPROM) that identifies the node manufacturer, functionality of device (application & sequence), transceiver used, and intended device usage.

1.4.65 Property (BACnet)

A BACnet Property - a data element associated with an Object. Different Objects have different Properties, for example an Analog Input Object has a Present_Value Property (which provides the value of the underlying hardware analog input), a High_Limit Property (which contains a high limit for alarming), as well as other properties.

1.4.66 Protocol Implementation Conformance Statement (PICS)(BACnet)

A document, created by the manufacturer of a device, which describes which potions of the BACnet standard are implemented by a given device.

1.4.67 Repeater

A device that connects two control network segments and retransmits all information received on one side onto the other.

1.4.68 Router (LonWorks)

A device that connects two channels and controls traffic between the channels by retransmitting signals received from one subnet onto the other based on the signal destination. Routers are used to subdivide a control network and to control bandwidth usage.

1.4.69 Router (BACnet)

A device that connects two or more BACnet networks and controls traffic between the networks by retransmitting signals received from one network onto another based on the signal destination. Routers are used to subdivide an internetwork and to control bandwidth usage.

1.4.70 Segment

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type. For example, a TP/FT-10 segment with locally powered devices is limited to 64 devices, and a BACnet MS/TP segment is limited to 32 devices.

1.4.71 Service (BACnet)

A BACnet Service. A defined method for sending a specific type of data between devices. Services are always defined in a Client-Server manner, with a Client initiating a Service request and a Server Executing the Service. Some examples are ReadProperty (a client requests a data value from a server), WriteProperty (a client writes a data value to a server), and CreateObject (a client requests that a server create a new object within the server device).

1.4.72 Service Pin (LonWorks)

A hardware push-button on a device which causes the device to broadcast a message containing its Node ID and Program ID. This broadcast can also be initiated via software.

1.4.73 Standard BACnet Object/Property/Service (BACnet)

BACnet Objects, Properties, or Services that are standard Objects, Properties, or Services enumerated and defined in ASHRAE 135. Clause 23 of ASHRAE 135 defines methods to extend ASHRAE 135 to non-standard or proprietary information. Standard BACnet Objects/Properties/Services specifically exclude any vendor specific extensions.

1.4.74 Standard Configuration Property Type (SCPT) (LonWorks)

Pronounced 'skip-it'. A standard format type (maintained by LonMark

International) for Configuration Properties.

1.4.75 Standard Network Variable Type (SNVT) (LonWorks)

Pronounced 'snivet'. A standard format type (maintained by LonMark International) used to define data information transmitted and received by the individual nodes. The term SNVT is used in two ways. Technically it is the acronym for Standard Network Variable Type, and is sometimes used in this manner. However, it is often used to indicate the network variable itself (i.e. it can mean "a network variable of a standard network variable type"). In general, the intended meaning should be clear from the context.

1.4.76 Subnet (LonWorks)

Consists of a logical grouping of up to 127 nodes, where the logical grouping is defined by node addressing. Each subnet is assigned a number which is unique within the Domain. See also Node Address.

1.4.77 Supervisory Controller

A controller implementing a combination of supervisory logic (global control strategies or optimization strategies), scheduling, alarming, event management, trending, web services or network management. Note this is defined by use; many supervisory controllers have the capability to also directly control equipment.

1.4.78 Supervisory Gateway

A device that is both a supervisory controller and a gateway, such as a Niagara Framework Supervisory Gateway.

1.4.79 TP/FT-10 (LonWorks)

A Free Topology Twisted Pair network (at 78 kbps) defined by CEA-709.3. This is the most common media type for a CEA-709.1-D control network.

1.4.80 TP/XF-1250 (LonWorks)

A high speed (1.25 Mbps) twisted pair, doubly-terminated bus network defined by the LonMark Interoperability Guidelines. This media is typically used only as a backbone media to connect multiple TP/FT-10 networks.

1.4.81 UMCS Network

An IP network connecting multiple field control systems to the Monitoring and Control Software using one or more of: LonWorks (CEA-709.1-D and CEA-852-C), BACnet (ASHRAE 135 Annex J), MODBUS Protocol, MODBUS TCP/IP or OPC DA.

1.4.82 User-defined Configuration Property Type (UCPT) (LonWorks)

Pronounced 'u-keep-it'. A Configuration Property format type that is defined by the device manufacturer.

1.4.83 User-defined Network Variable Type (UNVT) (LonWorks)

A network variable format defined by the device manufacturer. Note that

UNVTs create non-standard communications (other vendor's devices may not correctly interpret it) and may close the system and therefore are not permitted by this specification.

1.4.84 Utility Control System (UCS)

One type of field control system. Used for control of utility systems such as an electrical substation, sanitary sewer lift station, water pump station, etc. Building controls are excluded from a UCS, however it is possible to have a Utility Control System and a Building Control System in the same facility, and for those systems to share components such as the FPOC. A UCS may include its own local front-end.

PART 2 PRODUCTSPART 3 EXECUTION

3.1 INTEGRATION OF FIELD CONTROL SYSTEMS

Fully integrate the field control systems in accordance with the following three step sequence and as specified and shown.

STEP 1: Install and configure Control Hardware as necessary to connect the field control system to the FPOC, which is part of the UMCS IP network, and to provide control protocol translation and supervisory functionality.

STEP 2: Add Field Control System to M&C Software: Perform system discovery, system database merges, or any other actions necessary to allow M&C Software access to the field control system.

STEP 3: Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

3.1.1 Integration Step 1: Install Control Hardware

Install Control Hardware as specified at the FPOC location to connect the field control system to the UMCS IP network via the FPOC and, if necessary, to provide control protocol translation and supervisory functionality. Coordinate all connections and other activities related to an FPOC with the COR. Depending on the field control system media and protocol this must be accomplished through one of the following:

a. Connect the existing field control network hardware at the FPOC location to the FPOC.

b. Install a Niagara Framework Supervisory Gateway connected to both the field control network and the FPOC.

3.1.1.1 Installation of Niagara Framework Supervisory Gateway

Install Niagara Framework Supervisory Gateway hardware to connect the field control network to the FPOC. Install additional field control system network media and hardware as needed to connect the Niagara Framework Supervisory Gateway to the field control system.

3.1.2 Integration Step 2: Add Field Control System to M&C Software

Perform system discovery, system database merges, or any other actions

necessary to allow M&C Software access to points and data in the field control system.

3.1.2.1 Integration of Field Control Systems Via Niagara Framework

For each Niagara Framework Supervisory Gateway installed in integration step 1 for this project do both of the following:

a. Use the Niagara Framework Engineering Tool to fully discover the field control system and make all field control system information available to the Niagara Framework Supervisory Gateway.

b. Create and configure points and establish network communication between the Niagara Framework Supervisory Gateway and the field control system to provide points from the field control system to the M&C software and to provide support for supervisory functions, including but not limited to schedule objects, trend logs and alarming.

For each Niagara Framework Supervisory Gateway to be integrated as part of this project, make all information in the Niagara Framework Supervisory Gateway available to the M&C Software.

3.1.3 Integration Step 3: Configure M&C Software

Configure M&C Software to provide monitoring and control of the field control system, including but not limited to the creation of system displays and the configuration of scheduling, alarming, and trending.

3.1.3.1 Configure M&C Software Communication

Create and configure points and establish network communication between M&C Software and Field Control Systems as specified to support M&C Software functionality:

a. Update points on currently active displays via polling as necessary to meet M&C Software display refresh requirements.

b. Send points used for overrides to the device receiving the override as shown on the Points Schedule.

3.1.3.2 Configure M&C Software Functionality

Fully configure M&C Software functionality using the M&C Software capabilities specified in PART 2 of this Section.

a. Create System Displays using the project site sample displays, including overrides, as shown on the Points Schedule and as specified. Label all points on displays with full English language descriptions. Configure user permissions for access to and executions of action using graphic pages. Coordinate user permissions with the Controls shop supervisor

b. Configure alarm handling as shown on the Points Schedule, as shown on the Alarm Routing Schedule, and as specified. For alarms requiring notification via text message or e-mail, configure the alarm notification to use the specified Government furnished SMTP server to send the alarm notification.

c. Configure scheduling as indicated and as shown on the points

schedule.

Create and configure displays for configuration of Schedule Objects in the field control system. Label schedules and scheduled points with full English-language descriptors. Provide a separate configuration capability for each schedule. A single configuration display may be used to configured multiple schedules, provided that each schedule is separately configurable from the display.

d. Trend points at 15 minute intervals.

Create and configure displays for creation and configuration of trends and for display of all trended points.

e. Configure Demand Limiting as shown on the Demand Limit Schedule and Points Schedule and as specified.

f. Configure M&C Software standard reports.

3.2 START-UP AND START-UP TESTING

Test all equipment and perform all other tests necessary to ensure the system is installed and functioning as specified. Prepare a testing report documenting all tests performed and their results and certifying that the system meets the requirements specified in the contract documents.

-- End of Section --

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SECTION 26 05 48

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SECTION 26 05 48

SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.21.1	(2009; R 2016) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.22M	(1981; R 2017) Metric Plain Washers

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2023) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts

ASTM A572/A572M	(2021; E 2021) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A603	(2019) Standard Specification for Zinc-Coated Steel Structural Wire Rope
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM E580/E580M	(2024) Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
ASTM F436	(2011) Hardened Steel Washers
ASTM F959/F959M	(2017a; R 2023) Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC ES AC156	(2012) Acceptable Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

METAL FRAMING MANUFACTURERS ASSOCIATION (MFMA)

MFMA-4	(2004) Metal Framing Standards Publication

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-810	(2022; Rev H; Change 1) Environmental Engineering Considerations and Laboratory Tests
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering
UFC 3-301-02	(2023) Design of Risk Category V Structures, National Strategic Military

Assets

UL SOLUTIONS (UL)

UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires

VIBRATION ISOLATION AND SEISMIC CONTROL MANUFACTURERS ASSOCIATION (VISCMA)

VISCMA 413	(2014) Installing Seismic Restraints for Electrical Equipment

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Design and provide seismic supports and attachments in accordance with UFC 3-301-01, UFC 3-301-02and ASCE 7-16. Design and provide seismic supports and attachments, and isolation and energy dissipation systems in accordance with UFC 3-301-02.

Components, supports, and attachments must comply with following structural design criteria:

Risk Category: V.

Seismic Design Category: C.

Seismic Design Spectral Response Acceleration Parameter at Short Period (SDS): 0.0251 g.

Seismic Design Spectral Response Acceleration Parameter at period of 1 second (SD1): 0.083 g.

Seismic relative displacement within structure, between height 0' 0" and height 29' 0": 1.0 inches.

Apply the seismic requirements described in this section and on the drawings to the electrical components listed in paragraph ELECTRICAL COMPONENTS.

Electrical components and their supports must be attached or anchored to structure.

1.2.2 Electrical Components

Provide seismic supports and attachments for the following electrical components in accordance with the requirements of this specification:

Mission Critical Level 1 (MC-1) Components in Risk Category V designed in accordance with UFC 3-301-02:

Battery Systems
Generators
Transformers
Motors

Mission Critical Level 2 (MC-2) Components in Risk Category V designed in

accordance with UFC 3-301-02:
Control Panels
Light Fixtures
Switchboards
Storage Racks
Uninterruptible Power Supply Systems
Distribution Systems Conduit, Cable Tray, Busway, and Raceway
Utility and Service Lines
Emergency and standby power systems
Fire detection and suppression systems
Emergency exit lighting

1.2.3 Contractor Designed Supports and Attachments

Provide seismic supports and attachments, and isolation and energy dissipation systems for electrical components.

Contractor must retain services of a Registered Professional Engineer to design supports and attachments, and isolation and energy dissipation systems for electrical components. Supports and attachments, and isolation and energy dissipation systems that induce torsion in structural members are not permitted.

Submit copies of the Design Calculations and Design Drawings. Calculations and Drawings must be stamped and signed by Contractor's Registered Professional Engineer.

Submit Independent Design Review Report, prepared by Contractor's independent Professional Engineer for Risk Category V electrical components, supports and attachments, and isolation and energy dissipation systems in accordance with UFC 3-301-02.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office which will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Equipment Requirements; G, DO

Lighting Fixtures; G, DO

SD-03 Product Data

Supports and Attachments; G, DO

Equipment Requirements; G, DO

Lighting Fixtures; G, DO

Flexible Fittings; G, DO

Anchors; G, DO

Isolation And Energy Dissipation Systems; G, DO

Detail drawings showing bracing, supports, and anchorage, along with catalog cuts, templates, and erection and installation details, as appropriate, for the required items. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

SD-05 Design Data

Design Calculations; G, DO

Design Drawings; G, DO

Independent Design Review Report; G, DO

SD-06 Test Reports

Anchors; G, RO

SD-07 Certificates

ICC ES AC156 Shake Table Test; G, RO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

PART 2 PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

Equipment must be rugged enough to survive design seismic event. Equipment components designated as Designated Seismic Systems or MC-1 (Mission Critical Level 1) must remain operational as required in paragraph SPECIAL TESTING FOR SEISMIC-RESISTING EQUIPMENT.

Submit detail drawings of supports and attachments, and isolation and energy dissipation systems along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed in paragraph ELECTRICAL COMPONENTS. Indicate thickness, type, grade, class of metal, and dimensions; and show construction details, reinforcement, anchorage, and installation with relation to the building construction.

Submit calculations and drawings that are stamped and signed by Contractor's registered professional engineer. Design must be based on actual equipment and system layout. Design must include calculated loads and capacity of materials utilized for the connection of the equipment or system to the structure. Analysis must detail anchoring methods. Include drawing for Mission Critical Equipment and Designated Seismic System Equipment indicating the equipment location in the facility to be used for the installation. Equipment must be rigidly or flexibly mounted as indicated. Roof mounted equipment both vibration isolated and nonisolated, must have support members designed and anchored to building structure.

2.1.1 Rigidly (Base and Suspended) Mounted Equipment

The following specific items of equipment must be constructed and assembled to withstand the seismic forces specified in UFC 3-301-01 and UFC 3-301-02. Entirely locate each item of rigid electrical equipment and rigidly attach on one side only of a building expansion joint. Provide items such as electrical conduit, which cross the building expansion joint with flexible joints that are capable of accommodating displacements equal to the full width of the joint in each orthogonal direction.

Engine-Generators
Substations
Transformers
Switch Boards and Switch Gear
Motor Control Centers
Free Standing Electric Motors

Equipment furnished under this Contract must be rigidly mounted. For any rigid equipment which is rigidly anchored, provide flexible joints for electrical conduit, cabletray, busway, and raceway, that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions. Mission critical base mounted and suspended equipment for Risk Category (RC) V, and Designated Seismic Systems (DSS) for RC IV buildings assigned to Seismic Design Category (SDC) C, D, E, or F and Risk Category IV components needed for continued operation after an earthquake must have two nuts provided on each bolt.

2.2 LIGHTING FIXTURES

Provide lighting fixtures and supports and attachments conforming to UL 1598.

2.3 SUPPORTS AND ATTACHMENTS

Material used for members listed in this section and on the drawings, must conform with the following:

a. Plates, rods, and rolled shapes, ASTM A36/A36M, ASTM A572/A572M Grade 50, or ASTM A992/A992M.

b. Wire rope, ASTM A603 pre-stretched, with Class B weight zinc-coated wires throughout rope. Connect rope at ends using ferrule or saddle-type wire rope clamp systems. Ferrule clamps must be qualified by testing for use in seismic applications per VISCMA 413. Saddle-type clamps must be used with minimum of two clamps at each end of wire rope.

c. Tubes, ASTM A500/A500M, Grade B.

d. Pipes, ASTM A53/A53M, Grade B.

e. Angles, ASTM A36/A36M.

f. Channels (Struts) with in-turned lips and associated hardware for fastening to channels at discrete points conforming to MFMA-4.

g. Fasteners:

(1) High-strength bolts, ASTM F3125/F3125M, Grade A325, heavy hex.

(2) Nuts, ASTM A563. Use heavy hex nuts for high strength bolts and anchor bolts.

(3) Washers, ASME B18.22M and ASME B18.21.1, except use ASTM F436 washers for high strength bolts.

(4) Galvanized coating, ASTM A153/A153M.

(5) Direct Tension Indicator Washers, ASTM F959/F959M. Provide ASTM B695, Class 55, Type 1 galvanizing. Submit product data for direct tension indicator washers.

(6) Standard bolts, ASTM A307.

h. Anchor bolts:

(1) Cast in anchors: Refer to Section 05 12 00 STRUCTURAL STEEL 05 50 13 MISCELLANEOUS METAL FABRICATIONS for requirements.

(2) Post-installed anchors: Refer to Section 05 05 20 POST-INSTALLED CONCRETE AND MASONRY ANCHORS for requirements.

i. Welding: Refer to Section 05 12 00 STRUCTURAL STEEL Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

2.4 FLEXIBLE FITTINGS

Provide flexible fittings to allow conduit, cabletray, busway, and raceway systems to accommodate seismic movement between equipment and conduit, cabletray, busway, and raceway systems and supporting structure. Use specification grade steel fittings conforming to MIL-STD-810. Provide suitable expansion fittings that maintain electrical continuity by bonding jumper or other means. Flexible fittings must accommodate minimum of 4 inches seismic movement in each orthogonal directions.

PART 3 EXECUTION

3.1 SUPPORTS AND ATTACHMENTS

Provide supports and attachments with continuous load path to distribute electrical component seismic loads to structure.

Provide supports and attachments for electrical components that conform to the arrangements shown to UFC 3-301-01 and UFC 3-301-02 requirements. Install vertical diagonal braces at a 45-degree slope. Where interference is present, the slope may be minimum of 30 degrees or a maximum of 60 degrees per VISCMA 413.

Provide bolted and welded connections for supports and attachments in accordance with UFC 3-301-01and UFC 3-301-02.

Provide welding in accordance with AWS D1.1/D1.1M.

3.2 BUILDING DRIFT

Do not attach electrical components to two dissimilar structural elements of a building that may respond differentially during an earthquake unless a flexible joint is provided. Electrical components, supports, and attachments must be capable of accommodating building story drifts,

deflections, and relative displacements.

3.3 CONDUIT, CABLETRAY, BUSWAY, AND RACEWAY

Provide supports and attachments for conduit, cabletray, busway, and raceway conforming to the requirements of UFC 3-301-01 and UFC 3-301-02.

3.4 LIGHTING FIXTURES

Provide lighting fixtures and supports conforming to the following:

3.4.1 Pendant Fixtures

Provide pendant fixtures conforming to the requirements of UFC 3-301-01 and UFC 3-301-02.

3.4.2 Ceiling Attached Fixtures

3.4.2.1 Recessed Fixtures

Support recessed individual or continuous-row mounted fixtures by a seismic-resistant suspended ceiling support system built in accordance with ASTM E580/E580M. Provide supports and attachments for the fixtures conforming to the requirements of UFC 3-301-01 and UFC 3-301-02. Recessed lighting fixtures not over 56 pounds in weight and not required to be supported separately from the structure, may be supported by and attached directly to the ceiling system runners using screws or bolts, number and size as required by the seismic design. Provide lock or screw attachments for fixture accessories, including diffusers and lenses.

3.4.2.2 Surface-Mounted Fixtures

Attach surface-mounted individual or continuous-row fixtures to a seismic-resistant ceiling support system built in accordance with ASTM E580/E580M. Provide supports and attachments for the fixtures conforming to the requirements of UFC 3-301-01 and UFC 3-301-02.

3.4.3 Assembly Mounted on Outlet Box

Design a supporting assembly, that is intended to be mounted on an outlet box, to accommodate mounting features on 4 inch boxes, plaster rings, and fixture studs.

3.4.4 Wall-Mounted Emergency Light Unit

Design and secure attachments for wall-mounted emergency light units for the worst expected seismic disturbance at the site.

3.5 ANCHORS

3.5.1 General

Submit copies of test results to verify the adequacy of the specific anchor and application, as specified. Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices allowing adequate edge distance and embedment depth for restraint anchor bolts. Identify position of reinforcing steel and other embedded items prior to drilling holes for post-installed anchors. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design

strength. Fill annular gap with nonshrink grout at equipment anchor bolts where clearance between anchor and equipment support hole exceeds 0.125 inches.

3.5.2 Cast-In-Place Anchors

Use templates to locate cast-in-place bolts accurately and securely in formwork. Provide anchor bolts with an embedded straight length with heavy hex nut and washer as to provide required strength and ductility. Anchor bolts that exceed the normal depth of equipment foundation piers or pads must either extend into concrete floor or the foundation or increase depth of the piers or pads to accommodate bolt lengths.

3.5.3 Post-Installed Anchors

Refer to Section 05 05 20 POST-INSTALLED CONCRETE AND MASONRY ANCHORS for requirements.

3.6 EQUIPMENT SUPPORT REQUIREMENTS

3.6.1 Suspended Equipment

Provide supports and attachments for components supported from structural systems. Provide supports and attachments that consist of angles, rods, wire rope, bars, channels (struts) or pipes arranged as shown in bracing submittals and secured at both ends with not less than 1/2 inch bolts. Provide sufficient supports and attachments to resist seismic forces as specified in UFC 3-301-01 and UFC 3-301-02 without exceeding capacity of structural components.

Submit details of supports and attachments for acceptance. In lieu of bracing with vertical supports, these items may be supported with hangers inclined at 45 degrees directed up and radially away from equipment and oriented symmetrically in 90-degree intervals on the horizontal plane, bisecting the angles of each corner of the equipment, provided that supporting members are properly sized to support operating weight when hangers are inclined. Where interference is present, the inclined hanger slope may be minimum of 30 degrees or a maximum of 60 degrees per VISCMA 413.

3.6.2 Floor or Pad Mounted Equipment

3.6.2.1 Shear Resistance

Bolt components to floor or pads. Provide bolts to resist seismic forces in accordance with paragraph ANCHORS.

3.6.2.2 Overturning Resistance

Use the ratio of the overturning moment from seismic forces to the resisting moment due to gravity loads to determine if overturning forces need to be considered in the sizing of anchor bolts. Provide calculations to verify the adequacy of the anchor bolts for combined shear and tension. Provide bolts to resist seismic forces in accordance with paragraph ANCHORS.

3.7 SPECIAL TESTING FOR SEISMIC-RESISTING COMPONENTS

Electrical components designated as Designated Seismic Systems or MC-1

(Mission Critical Level 1) required to remain operational after an earthquake must be seismic qualified by shake table testing conforming to ICC ES AC156 Shake Table Test procedures. The manufacturer is to provide a certification by a fully qualified testing agency for the specific components. Prequalified certifications are acceptable unless noted otherwise. Seismic qualification documentation for each component must contain the information required in UFC 3-301-02, Section 2-17.2.5 Component Qualification Documentation.

Components that are required to be certified must bear permanent marking or nameplates constructed of a durable heat and water resistant material.

Provide component identification nameplates in accordance with UFC 3-301-01 UFC 3-301-02.

Mechanically attach nameplates to electrical components.

3.8 SPECIAL INSPECTION FOR COMPONENTS, SUPPORTS, AND ATTACHMENTS

Perform special inspections for seismic-resisting systems, designated seismic systems, components, supports and attachments, and equipment per Section 01 45 35 SPECIAL INSPECTION attachment Schedule of Special Inspections and ICC IBC 1705.13.4; electrical components per ICC IBC 1705.13.6, and seismic isolators and energy dissipation systems per UFC 3-301-02.

Special Inspector must examine Designated Seismic Systems requiring seismic qualification in accordance with ASCE 7-16 and verify the label, anchorage and mounting conform to the certificate of compliance.

Provide a Statement of Special Inspections and Final Special Inspection Report in accordance with UFC 3-301-01 and UFC 3-301-02.

-- End of Section --

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SECTION 26 05 73

POWER SYSTEM STUDIES
08/23

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. AIR FORCE (USAF)

AFI 33-210	(2008) Certification and Accreditation (C&A) Program

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 242	(2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book
IEEE 399	(1997) Brown Book IEEE Recommended Practice for Power Systems Analysis
IEEE 1015	(2006; Corr dated 2007) Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems - IEEE Blue Book (Color series)
IEEE 1584	(2018; E 2019) Guide for Performing Arc-Flash Hazard Calculations
IEEE 3002.2	(2018) Recommended Practice for Conducting Load-Flow Studies and Analysis of Industrial and Commercial Power Systems
IEEE 3002.3	(2018) Recommended Practice for Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.010	(2016)IEEE Application Guide for AC High-Voltage Circuit Breakers > 1000 Vac Rated on a Symmetrical Current Basis
IEEE C37.20.1	(2020) Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit-Breaker Switchgear
IEEE C37.46	(2010) Standard for High Voltage Expulsion and Current-Limiting Type Power Class Fuses and Fuse Disconnecting Switches

IEEE C57.12.00	(2021) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.10	(2017) Requirements for Liquid-Immersed Power Transformers
IEEE C57.96	(2013) Guide for Loading Dry-Type Distribution and Power Transformers

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA P-32-382	(2013; R2013) Short Circuit Characteristics of Insulated Cables
ICEA P-45-482	(2013) Short Circuit Performance of Metallic Shields and Sheaths on Insulated Cables

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-501-01	(2015; with Change 2, 2023) Electrical Engineering
UFC 3-560-01	(2017; with Change 2, 2019) Operations and Maintenance: Electrical Safety

1.2 SYSTEM DESCRIPTION

The power system covered by this specification consists of all electrical systems downstream of medium voltage switches at ST-MH-3, ST-MH-5, and ST-MH-7.

The load flow analysis, fault current analysis, the arc flash hazard analysis, and the protective device coordination study shall begin at the source bus at the medium voltage switches at ST-MH-3 and ST-MH-5, new transfomers (T442C, T442D, T442A, and T442B), and shall include all medium and low voltage equipment and devices extending down to the facility system buses as shown on the EP600 series sheets. Anything labeled "West Trucks" are not to be included within this analysys. The analysis above must also include any equipment associated and down stream of ST-MH-7, including transformers, distribution panels, etc.

Note the conditions provided by the private utility provider (Xcel) will be representative of characteristics at the Automatic Throwover Switch, and will require the study to incorporate the infrastructure features not

yet present at the time of solicitation. The drawings for the work to which this contract's work will be connecting at the switches identified on the plans are included as an attachment to this solicitation; the contractor must field investigate the installed conditions of the aforementioned infrastructure for the final studies. Studies must examine operating conditions of current flowing in either direction on the government-owned medium voltage electrical loop.

1.3 SUBMITTALS

The Contractor shall not submit nor shall submittals be considered approved for installation on any electrical equipment containing overcurrent protective devices or requiring a short circuit rating or an arc flash rating until the Power System Studies have been submitted for review by the Contractor and until it has been approved (transmittal "A" or "B" Action) by the reviewing agent.

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.

The devices, equipment, and products included in the analysis shall match those submitted for approval. If any devices, equipment, and products are changed or resubmitted for approval, the system analysis shall be updated accordingly and resubmitted with all updated or impacted portions of the analysis clearly identified. On re-submittals, the contractor shall include the acknowledgement of and/or response to all comments from the prior submittal, including identification of where changes are made incorporating the review comments. Changes to previously-approved items or subportions of items shall be clearly identified and include a statement regarding the purpose of the change.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Field Examination Plan; G, RO

Arc Flash Label Formats; G, RO

SD-03 Product Data

Allow a minimum of 45 calendar days exclusive of mailing for Government reviews and approvals.

Determination of Facts; G, DO
Documentation of Utility Characteristics; G, DO

Interim Load Flow Study; G, DO
Interim Fault Current Analysis; G, DO
Interim Protective Device Coordination Study; G, DO

Final Load Flow Study; G, DO
Final Fault Current Analysis; G, DO
Final Protective Device Coordination Study; G, DO

Arc Flash Hazard Analysis; G, DO

Transformer Inrush Data; G, DO
Protective Relay Settings; G, DO
Installation; G, DO
Adjustable-Trip Circuit Breaker Circuit Corrections; G, DO

Interim Load Flow Study (Offload); G, DO
Interim Fault Current Analysis (Offload); G, DO
Interim Protective Device Coordination Study (Offload); G, DO

Final Load Flow Study (Offload); G, DO
Final Fault Current Analysis (Offload); G, DO
Final Protective Device Coordination Study (Offload); G, DO

Arc Flash Hazard Analysis (Offload); G, DO

SD-06 Test Reports

Field Examination; G, RO

SD-07 Certificates

System Coordinator; G, RO

SD-11 Closeout Submittals

Closeout submittals shall include data for the offload distribution system in addition to the powerplant and powerplant-supported distribution system.

Model Files; G, RO

Load Flow Study; G, RO

Fault Current Study; G, RO

System Coordination Study; G, RO

Arc Flash Hazard Study; G, RO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 QUALITY ASSURANCE

1.4.1 System Coordinator

The system coordination; recommended ratings and settings of protective devices; design analysis; short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies. Submit verification of experience and license number, of a registered Professional Engineer as specified above. Experience data shall include

at least five references for work of a magnitude comparable to this contract, including points of contact, addresses and telephone numbers.

The system coordinator information shall be submitted prior or simultaneous to any study/analysis information.

1.4.2 System Installer

Calibration, testing, adjustment, and placing into service of the protective devices shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience in protective devices.

1.4.2.1 Delivery, Storage, and Handling

Devices and equipment shall be visually inspected when received and prior to acceptance from conveyance. Protect stored items from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced.

PART 2 PRODUCTS

2.1 Interim Studies for Equipment Release

The following interim studies may be submitted for the purpose of expediting the approval of long-lead items:

Interim Load Flow Study
Interim Fault Current Analysis
Interim Protective Device Coordination Study

The interim studies shall use the procedures described in this Section with the following exceptions:

The following characteristics at the point of connection (Xcel-owned Automatic Throwover Switch):
Available Fault Current: 9,000A.
Source A Positive Sequence X/R ratio: 3.714.
Source A Zero Sequence X/R ratio: 1.631.
Source B Positive Sequence X/R ratio: 2.918.
Source B Zero Sequence X/R ratio: 0.605.
Infinite Bus Available Fault Current for the primary supply to Transformers DTA and DTB.
ANSI Standard Transformer Inrush Data.
Loads (including motors) shown on the plans.
Non-adjustable protective device ratings shown on the plans.
Conductor sizes shown on the plans (other than adjustments to be made based on adjustable trip breaker rating changes in the interim studies).

All final studies to be used for incorporation into closeout submittals and equipment labeling must represent the installed conditions, including but not limited to the following:

Available fault characteristics from the utility provider (Xcel).
Manufacturer-provided transformer inrush and impedance data.
Conductor sizes (as those identified on the plans are identified as minimum values).
Conductor lengths.

Conductor insulation (the temperature ratings on the plans are identified as minimum values).
Raceway material.
Characteristics of contractor-furnished devices requiring electrical connections and the adjusted conductor and/or protection ratings required thereof.

Ensuring proper protective and selective coordination of the distribution system, and must adjust the ratings and characteristics of the equipment provided should new information introduced to the required studies yield unsafe or uncoordinated results. Provide circuit breakers with high-instantaneous trip properties where needed to satisfy selective coordination requirements.

2.2 Offload

The pumped offload outside the Restricted Area fence requires the same studies to be performed but connects to the medium-voltage infrastructure separate from the remainder of work in this contract. Perform studies with the same requirements but submitted as separate items:

Interim Load Flow Study (Offload)
Interim Fault Current Analysis (Offload)
Interim Protective Device Coordination Study (Offload)
Final Load Flow Study (Offload)
Final Fault Current Analysis (Offload)
Final Protective Device Coordination Study (Offload)
Arc Flash Hazard Analysis (Offload)

2.3 COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. They shall include a load flow analysis, a Fault Current Analysis, Protective Device Coordination Study, Protective Relay Settings, and Arc Flash Hazard Analysis. Submit the study along with protective device equipment submittals. No time extensions or similar contact modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last 5 years. Provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

Additionally, submit transformer inrush data from the manufacturer associated with the transformers submitted under Section 26 20 00 ELECTRICAL DISTRIBUTION SYSTEM. The inrush data for the products proposed to be installed shall be incorporated into the protective coordination curves. The contractor shall notify the COR should the trip and/or frame rating of the transformer protective device require a change from the contract drawings.

The contractor shall notify the COR where the fault current at a non-fused disconnect is greater than 10kAIC.

2.3.1 Scope of Analyses

The load flow analysis, fault current analysis, and protective device coordination, and arc flash studies shall begin at the source bus and extend down to system buses for building/facility low voltage (120V through 480V) level distribution buses.

Facilities with generators shall include the generator in the analysis. The analysis shall include all possible combinations associated with the generator.

Study shall include all loads and shall include motor contributions for motors which are 10 hp and larger (including identified government-furnished and future equipment). The study shall run the short circuit and arc flash hazard analysis with the motor or motors on and off to determine the worst case. If more than one motor the analysis shall show both off, one running and both running. If more than two motors, the same pattern of adding a motor shall be followed.

Loads used in the analysis shall include spare loads listed on panel schedules and power one-line diagram.

2.3.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. Coordinate with the Buckley SFB CES and Xcel Energy for fault current availability at the site.

Available fault currents provided in this subpart are for estimation purposes only. Contractor shall verify the available fault currents with the local utility prior to performing analyses. Include in documentation communication with Buckley SFB CES and Xcel Energy regarding utility characteristics required for the studies.

Documentation of Utility Characteristics:

Service voltage and configuration
Maximum available 3-phase fault current
Maximum available 1-phase fault current
Positive Sequence X/R ratio at the primary service point
Zero Sequence X/R ratio at the primary service point
Equipment and circuit protection properties

Note a companion project is occurring to install a new electrical utility loop; advertisement drawings for that solicitation have been provided as "For Information Only" in this contract to assist in assembling the study. Contractor shall field verify the conditions for inclusion in this contract's power system studies as the utility demarcation is not directly connected to this contract's scope. Additionally, this contract will increase the capacity of the utility service, likely requiring a new source with characteristics differing from that included in the conservative design estimations.

Provide product installation drawings which include detailed connection wiring diagrams and indicate all processors/platforms and connections to other systems such as SCADA, EMCS, Smart Metering or other. Identify the smart meter (utility metering) enclave and SCADA enclave.

Power system data base shall be gathered and tabulated to support the study. The information shall include the equipment nameplate data and the protective device settings:

a. Impedance of service entrance.

b. Electrical Distribution System:

(1) Circuit-breaker and fuse-current ratings and types.

(2) Relays and associated power and current transformer ratings and ratios.

(3) Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance and X/R ratios.

(4) Generator kilovolt amperes, size, voltage, and source impedance.

(5) Cables: Indicate conduit material, sizes of conductors, conductor material, insulation and length.

(6) Motor horsepower and code letter designation according to NEMA MG 1. Only those 10 HP and larger (including identified government-furnished and future equipment).

c. Data sheets to supplement electrical distribution system input data, cross-referenced with tag numbers on diagram, showing the following:

(1) Special load considerations, including starting inrush currents and frequent starting and stopping.

(2) Transformer characteristics, including primary protective device, magnetic inrush current and overload capability.

(3) Motor full-load current, locked rotor current, service factor, starting time, type of start and thermal-damage curve.

(4) Generator thermal-damage curve.

(5) Ratings, types, and settings of utility company's overcurrent protective devices.

(6) Time-current-characteristic curves (TCCs) of devices indicated to be coordinated. Where TCCs are provided as "typical", indicate for which circuit(s) a given TCC applies.

(7) Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, instantaneous adjustment range, and ground-fault adjustment range for circuit breakers.

(8) Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range and current transformer ratio for overcurrent relays.

(9) Panelboards and switchboards ampacity and interrupting rating in amperes rms symmetrical.

The studies shall incorporate the actual equipment to be installed by the contractor, along with GF/GI equipment, and loads identified as "future" identified in the contract.

2.3.3 Single-Line Diagram

Single line diagrams shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). Fault-impedance diagrams or computer analysis diagrams may be provided. Each bus, device or transformation point shall have a unique identifier. If fault-impedance diagrams are provided, impedance data shall be shown. Location of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

2.3.4 Computer Analysis Software

The studies shall be performed using computer analysis software. Only EasyPower is certified in accordance with UFC 3-501-01 and AFI 33-210 for use on standard desktop systems connected to the Air Force Global Information Grid and placed on the Air Force Evaluated/Approved Products List. Other software products can be used on standard desktop systems connected to the Air Force Global Information Grid after they have been certified in accordance with AFI 33-210 and placed on the Air Force Evaluated/Approved Products List.

2.3.5 Load Flow Study

Perform the load flow study in accordance with IEEE 3002.2 to identify initital steady-state conditions for the fault current study. For each operating scenario, provide load flow results on the diagram or in the report. Show or describe the loading factors and assumptions used in each operating mode.

2.3.6 Fault Current Study

The powerplant will have a soft transition between the generator and utility sources. Powerplant fault current study results shall be based contributions for closed transition function.

2.3.6.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE 242, IEEE 399, and IEEE 3002.3.

a. Transformer design impedances shall be used when test impedances are not available.

b. Provide the following:

(1) Calculation methods and assumptions.

(2) Selected base per unit quantities.

(3) One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus

location and other information pertinent to the computer analysis.

(4) The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.

(5) Software shall calculate maximum available three-phase fault current. Also, different levels of fault current is required to be calculated based on different levels indicated in the arc flash hazard analysis requirements.

(6) Study electrical distribution system from normal and alternate power sources throughout electrical distribution system. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

(7) Calculations to verify interrupting ratings of overcurrent protective devices shall also comply with:

(a) Transformers: IEEE C57.12.10, IEEE C57.12.00, and IEEE C57.96.

(b) Medium-Voltage Circuit Breakers: IEEE C37.010.

(c) Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.

(d) Low-Voltage Fuses: IEEE C37.46.

(8) Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.

(9) Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

c. Protective Device Evaluation:

(1) Evaluate equipment and protective devices and compare to short circuit ratings.

(2) Adequacy of switchboard and panelboard bus bars to withstand short-circuit stresses.

(3) Contractor shall notify Owner in writing, of any circuit protective devices improperly rated for the calculated available fault current.

d. Include motors 10 hp and larger (including identified government-furnished and future equipment) in the short circuit analysis as previously discussed.

e. Motors with variable frequency/adjustable speed drives shall assume operation in bypass mode for fault current calculations.

2.3.6.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedance shall be those proposed. Data shall be documented in the report.

2.3.6.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

Where the available fault current at the source bus is not available, describe how the fault contribution from the source bus was determined and why this method is reasonable for the study.

2.3.7 System Coordination Study

Use the results of the load flow study and fault current analysis. For normal modes of operation, demonstrate that selectivity has been obtained between the devices within the scope of the project.

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. For portions of the distribution system(s) not required by code to fully selectively coordinate, protective devices and/or settings shall be selected to coordinate to less than or equal to 0.10 seconds. In addition to those required by code to selectively coordinate, each "Dedicated Emergency" branch of the distribution system (see Section 28 31 70 INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE) shall selectively coordinate upstream to the medium voltage switchgear. The study shall include a description of the coordination of the protective devices in this project. A written narrative shall be provided describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings.

Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction) shall be provided. Recommendations for changes to the protection device ratings to satisfy the requisite degree of protective coordination shall not be considered the first course of action; different models of a given technology shall be examined to identify appropriate circuit breakers and settings. Note in the study where circuit breaker technology limitations (e.g., of all thermal magnetic type of a certain trip rating) result in a rating change (e.g., from 150A to 175A) or technology change (e.g., from thermal magnetic to solid state).

Composite coordination plots shall be provided on log-log graph paper. The study shall be performed in accordance with methods described in IEEE 399.

a. Calculate the maximum and minimum 1/2-cycle short-circuit currents.

b. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.

c. Calculate the maximum and minimum ground-fault currents.

The coordination study analysis shall provide the following information:

a. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

b. Include on each TCC graph, a complete title with descriptive device, bus, and feeder names.

c. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

d. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

e. Plot the following characteristics on the TCC graphs, where applicable:

(1) Medium voltage equipment overcurrent relays.

(2) Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

(3) Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.

(4) Transformer winding damage curves, both primary and secondary.

(5) Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.

(6) Medium voltage conductor damage curves.

(7) Ground fault protective devices, as applicable.

(8) Pertinent motor starting characteristics and motor damage points, where applicable.

(9) Pertinent generator short-circuit decrement curve and generator damage point.

f. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

g. Provide the following:

(1) Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices, buses, and feeders shown, settings of the adjustable devices and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

(2) The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located and the device number corresponding to the device on the system one-line diagram.

(3) A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

(4) Contractor shall notify Owner in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

h. Transformer Primary Overcurrent Protective Devices. Device shall

not operate in response to the following:
(1) Inrush current when first energized.
(2) Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for a particular transformer.
(3) Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
(4) Device settings shall protect transformer according to IEEE C57.12.00, for fault currents.

i. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

j. The following branches shall have selective (total) coordination:
(1) Dedicated fire protection branch from GSB 52-F7 and GSA 52-F4 EFP-1 in the one-line diagram.
(2) From GSB 52-F6 and GSA 52-F5 to Switchboards DHB and DHA to all distribution panels as shown in the one-line diagrams, including branch circuit devices. (Note: All components are part of an Uptime Institute Tier III or Tier IV system other than the distribution branches from Switchboards DHA and DHB through ATS-N and downstream thereof, which must selectively coordinate as the "Dedicated Emergency" branch of the distribution system (see reference above).)

k. The conductor ampacity ratings shall be adjusted for ambient temperature conditions and number of current carrying conductors as indicated on the E- and EP series sheets in accordance with NFPA 70.

l. Transformer Protection: Protect transformer windings against damage from fault currents. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary and secondary protection device or total clearing time of the fuse. Provide adjustable trip settings such that the transformer damage curve is protected by each the primary and secondary protection devices.

The contractor shall adjust installed conductor sizes (and associated raceway sizes) at the direction of the designer of record should the trip settings on the adjustable devices deviate from the rating indicated on the plans in cases required to comply with selective coordination requirements, as well as for protective coordination of all conductors.

2.3.8 Arc Flash Hazard Study

The Arc Flash Hazard Study must use the actual device settings and properties resulting from the studies performed and actual devices installed. Use identified modes of operation to determine the worst case arc flash energy. If not included in another study, include a description of the devices and device settings for the operating modes that provided the highest arc flash energy. Where the arc flash energies exceed 1.2 cal/cm^2 provide recommendations to reduce the arc flash energy to 1.2 cal/cm ^{2}. Any locations which cannot be reduced below 1.2 cal/cm2 without seriously comprimising system coordintion must be individually identified

and must require concurrance from the government that the incident energy cannot be reasonably reduced below 1.2 cal/cm2.

The study shall be in accordance with latest applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub part S, IEEE 1584, and IEEE C2NESC Standards. The study must be performed using IEEE 1584 for equipment rated 120V, 208V, 240V, 480V to 15 kV and NESC for equipment rated above 15 kV. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis and the protective device time-current coordination analysis, but shall not be finalized until the short circuit and protective device coordination studies are completed. All assumptions shall be documented in the report.

In addition to the analysis described above, provide the following:

a. The arc flash boundary and the incident energy shall be calculated at all disconnect switches, panelboards, switchboards, generator terminals, transformer primary and secondary terminals, and at all significant locations in the electrical distribution system where work could be performed on energized parts.

b. Circuits 240V or less fed by transformers 112.5 kVA or less shall still be evaluated.

c. Working distances shall be based on IEEE 1584. The calculated arc flash boundary shall be determined using those working distances.

d. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

e. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable, as well as any stand-by generator applications. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

f. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
   - Fault contribution from induction motors should not be considered beyond 5 cycles.

g. For each piece of ANSI rated equipment with an enclosed main device,

two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault (some indicate this to be the line or supply side). A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault (some indicate this to be the bus or load side). For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

h. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

i. For each piece of equipment or equipment cubicle, the enclosure dimensions and electrode configurations entered into the model shall match the equipment cutsheets submitted for approval.

j. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

k. Arc Flash calculations shall be based on actual overcurrent protective device clearing time using the calculated arcing fault current and arcing current variation in accordance with IEEE 1584. A maximum clearing time of 2 seconds will be used based on IEEE 1584 section B.1.2. Where it is not physically possible to move outside of the arc flash boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

l. Worst case personal protective equipment (PPE) for each bus/equipment in the model.

m. Working distances for the different scenarios and arcing fault energy levels. Once calculated, a recommendation shall be made to standardize the arc flash boundary to a common distance. This distance shall be broken into two categories: a distance for equipment operating over 600 volts and equipment 600 volts and less. The standardized distance will typically be the larger boundary from each category and round up to the nearest foot.

n. Provide the following:

(1) Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus names, nominal system voltages, bolted fault and arcing fault current levels, arc flash boundary distances, working distances, limited and restricted approach boundaries, minimum personal-protective equipment requirements and AFIE (Arc Flash Incident Energy) levels. Flag results where the arcing current variation provided the worst-case results.

(2) The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.

(3) The Arc-Flash Hazard Analysis shall include recommendations to reduce AFIE levels and enhance worker safety. Recommendations with associated pricing quotes for potential system and component changes shall be provided where the incident energy level is 40 Cals/cm2 or greater.

(4) The Arc-Flash Hazard Analysis shall indicate which system operating configuration (also referred to as mode of operation or operating scenario) resulted in the calculated worst-case values.

2.3.9 Study report

The results of the load flow, short-circuit, protective device coordination, breaker settings, protective relay settings, and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. Electronic and pdf copies of the entire report shall be provided along with the bound copy. The bound copy shall not be provided until the Certified Settings Records are complete.

a. The report shall include the following sections:

(1) Executive Summary including Introduction, Scope of Work, list of assumptions made, and Results/Recommendations.
(2) Load Flow Methodology, Analysis Results, and Recommendations.
(3) Short-Circuit Methodology, Analysis Results, and Recommendations.
(4) Short-Circuit Device Evaluation Table.
(5) Protective Device Coordination Methodology, Analysis Results, and Recommendations.
(6) Protective Device Settings Table.
(7) Time-Current Coordination Graphs and Recommendations.
(8) Arc Flash Evaluations Summary Spreadsheet (Maximum Energy Calculation).
(9) Arc Flash Evaluations Summary Spreadsheet (All Scenarios for each location Energy Calculation).
(10) Arc Flash Evaluations Summary Spreadsheet (identified at 'Dangerous' where the incident energy level is greater than 40 Cals/cm2).
(11) Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and arc flash boundary calculations, along with Nominal System Voltages, Arc Flash Boundary distances, working distances, Limited and Prohibited Approach Boundaries, Incident Energy levels, and minimum Personal Protection Equipment requirements for each location.
(12) The arc flash hazard reports shall list the following items: bus name, scenario, upstream protective device name, type and setting, bus line to line voltage, electrode configuration, enclosure dimensions, bus bolted fault, protective device bolted fault current, arcing fault current, protective device trip/delay time, breaker opening time, solidly grounded column, equipment type, gap, arc flash boundary, working distance, incident energy.
(13) Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.
(14) One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.
(15) Provide photographs of any equipment that is felt merits special attention.

b. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

c. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices. Tabular format of settings selected for overcurrent protection devices:
   (1) Device tag.
   (2) Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   (3) Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   (4) Fuse-current rating and type.
   (5) Ground-fault relay-pickup and time-delay settings.

d. Document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings;. Identify all assumptions about the protection devices, equipment, and system where data was not available.

e. The report shall document existing power system data including time-current characteristic curves and protective device ratings and settings.

f. The report shall contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   (1) Device tag.
   (2) Voltage and current ratio for curves.
   (3) Three-phase damage points for each transformer.
   (4) No damage, melting, and clearing curves for fuses.
   (5) Cable damage curves.
   (6) Transformer inrush points.
   (7) Maximum fault-current cutoff point.

g. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, software modules utilized, and version number shall be provided.

h. Any locations which cannot be reduced to 1.2 cal/cm2 without seriously compromising the system coordination must be individually identified and must require concurrence from the government if the incident energy cannot reasonably be reduced below 1.2 cal/cm2.

i. The System Analyzer must stamp the study reports.

PART 3 EXECUTION

3.1 FIELD EXAMINATION

For each pre- and post-study inspection, submit a field examination plan identifying which facilities must be examined to complete the required work. Include a complete information verification procedure, where Qualified Personnel will be required, PPE requirements for "live" equipment examinations, and equipment to be used within the limited approach boundary of the equipment.

3.1.1 General

Perform the post-study inspection(s) after changing settings, after performing acceptance tests, and before placing equipment in service.

3.1.2 Safety

Where examination of the equipment requires energized equipment to be opened, provide a Qualified Person to directly supervising any non-Qualified Person within the hazard area. Use PPE, protective barriers, danger signs and other safety devices to protect and warn personnel in the vicinity of "live" equipment being examined.

3.1.3 Adjustable-Trip Circuit Breaker Circuit Corrections

Prior to applying arc flash labels, the contractor shall field verify and document all field adjustible circuit breaker settings. The contractor shall document all settings and submit them to the government for verification that all settings implemented match those used in the studies and that all setting recommendations have been proprly implemented.

3.1.4 Application of Arc Flash Labels

Install arc flash warning labels using Qualified Personnel as necessary after the setting and inspection is complete. For new or modified equipment, install labels before the equipment is energized for the first time after installation/modification or setting changes. Schedule the label placement with the Contracting Officer at least 5 business days before label placement. Furnish all materials, labor, and equipment necessary to place the labels. Maintain a written record of the all equipment that received labels, personnel involved, and the date labels were placed.

3.2 POWER SYSTEM STUDIES

Perform power system studies to demonstrate that the equipment selected and system constructed meet the contract requirements for fault current and interrupt ratings, coordination, protection, and Arc Flash Hazard. Submit reports of the studies along with protective device equipment submittals. Apply Arc Flash Hazard labels to equipment after the studies are approved. Update and resubmit the studies after any changes to the equipment or systems which may affect the study results, and re-apply Arc Flash Hazard labels to equipment after the resubmitted studies are approved. The Government is not responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured before approval of the study.

3.2.1 Scope of Studies

The "source bus" is the source of energy for system being analyzed. This may be the energy feed from a utility, the first bus upstream of the work, generators within the work or upstream of the work, or any other source capable of contributing significant energy into the system being analyzed.

In the systems model for the studies, incorporate all existing and new equipment within the scope of the studies. Incorporate any additional sources or load equipment necessary to accurately model the system's performance.

Where multiple sources of power may be in service in various combinations or where electrical loops are in the system, incorporate into the studies all the modes of operation to evaluate the impact of the modes of operation on the system. The primary modes of operation are listed below.

1. Both Utility A side and B side Feeds Connected and powering the system with generators offline. Tie Breakers Open.

2. Utility A side Feed Connected and powering the system with generators offline. Tie Breakers Closed.

3. Utility B side Feed Connected and powering the system with generators offline. Tie Breakers Closed.

4. Both generator side A and B connected with both generators on each side running. Tie Breakers Open.

5. Both generator side A and B connected with a single generator on each side running. Tie Breakers Open.

6. Both utility A side and B side connected with both generator side A and B connected with both generators on each side running. Tie Breakers Open.

7. Both utility A side and B side connected with both generator side A and B connected with a single generator on each side running. Tie Breakers Open.

8. Utility A side connected with generator side B connected with both generators running. Tie Breakers Open.

9. Utility A side connected with generator side B connected with a single generator running. Tie Breakers Open.

10. Utility B side connected with generator side A connected with both generators running. Tie Breakers Open.

11. Utility B side connected with generator side A connected with a single generator running. Tie Breakers Open.

12. Generator side A connected with both generators running. Tie Breakers Closed.

13. Generator side B connected with both generators running. Tie Breakers Closed.

14. Offload utility feed.

3.2.2 Determination of Facts

Determine and document the time-current characteristics, features, ratings, ampacities, and nameplate data for each existing protective device, electrical equipment, and feeder cables. Obtain the available fault current from the owner of the source bus.

3.2.3 Single Line Diagram

Provide a single line diagram showing the electrical system buses, devices, transformation points, and all sources of load current and fault current, including generator and motor contributions. Provide a diagram from the system model. Each bus, device or transformation point must have a unique identifier. Show the location of switches, breakers, and circuit interrupting devices on the diagram together with available fault data, and the device interrupting rating.

The naming of existing components within the system model and single line diagram must match existing installed equipment names. The naming of new components within the system model and single line diagram must use unique identifiers and be coordinated with the Government.

3.2.4 Arc Flash Labels

Provide arc flash warning labels on electrical equipment likely to require examination, servicing, or maintenance while energized. Typical types of equipment include pad-mounted transformers, switchgear, switchboards, panelboards, disconnect switches, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling occupancies. The arc flash label naming must match the naming used in the system modeling and the single line diagram.

Comply with the label requirements specified in UFC 3-560-01. Obtain approval of arc flash label formats before printing.

a. Provide a 3.5 inch x 5 inch to 4 inch x 6 inch thermal transfer type label of high adhesion polyester for each location device analyzed. The label must remain in place and be legible for at least 5 years in the installed environment.

b. Labels must be machine printed with no field markings. Provide arc flash labels in the following manner. All labels must be based on implemented overcurrent devices and settings.

    1. Provide at least one arc flash label for each 480 volt and 208 volt panelboards.

    2. Provide at least one arc flash label for each low voltage (less than 1000 V) switchboard.

    3. Where the equipment construction has different hazards levels in different areas, provide a label for each compartment, cubicle, or section separated by barriers

c. Use the worst case hazard of all operating scenarios unless mitigation procedures are used. If mitigation procedures are used, explain the procedures on the label.

3.3 MODELING

Develop a software model of the electrical system identified in the scope of the studies. Use the latest version of EasyPower(TM). Develop the model with accurate, verified information. Model existing electrical equipment, machines, devices, and conductors directly connected to, altered by, or otherwise affected by the work. This includes, but is not limited to generators, transformers, switchgear, switchboards, panelboards, motor control centers, motors, voltage regulators, tap changers, protective relays, circuit breakers, switches, fuses, conductors, capacitors, reactors, grounding system, and control equipment.

Provide the final model files in their native editable formats for future use by the Government. Include device information for devices not in the software vendor's standard distribution.

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SECTION 26 08 00

APPARATUS INSPECTION AND TESTING

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SECTION 26 08 00

APPARATUS INSPECTION AND TESTING
11/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance Tests and Inspections; G, RO

SD-07 Certificates

Qualifications of Organization, and Lead Engineering Technician; G, RO

Acceptance Test and Inspections Procedure; G, RO

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph ACCEPTANCE TESTS AND INSPECTIONS herein. Organization must be independent of the supplier, manufacturer, and installer of the equipment. The organization must be a first tier subcontractor. No work required by this section of the specification may be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization must

have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization must have a calibration program, and test instruments used must be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments must be performed by an engineering technician, certified by NETA (Level III) or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

1.4.2 Acceptance Tests and Inspections Reports

Submit certified copies of inspection reports and test reports. Include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.

1.4.3 Acceptance Test and Inspections Procedure

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization will perform acceptance tests and inspections. Test methods, procedures, and test values must be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph FIELD QUALITY CONTROL of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Place equipment in service only after completion of required tests and evaluation of the test results have been completed. Supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Notify Contracting Officer at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

a. Section 26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES. Functional engine shutdown tests, vibration base-line test, and load bank test will not be performed by the testing organization, but by the start-up engineer.

b. Section 26 12 19.10 THREE-PHASE, LIQUID-FILLED PAD-MOUNTED TRANSFORMER

c. Section 26 36 23 AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH

d. Section 26 24 13 SWITCHBOARDS

3.2 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

3.3 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization must be present when equipment tested by the organization is initially energized and placed in service.

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D117	(2018) Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System
ASTM D3487	(2016; E2017) Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.47	(2011) Standard for High Voltage Distribution Class Current-Limiting Type Fuses and Fuse Disconnecting Switches
IEEE C57.12.00	(2021) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.34	(2022) Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 10 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.90	(2021) Test Code for Liquid-Immersed

	Distribution, Power, and Regulating Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 260	(1996; R 2004) Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas
NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

1.4 SUBMITTALS

The Contractor shall not submit nor shall submittals be considered approved for installation on any electrical equipment containing overcurrent protective devices or requiring a short circuit rating or an arc flash rating until the Power System Studies (Section 26 05 73) has been submitted for review by the Contractor and until it has been approved (transmittal "A" or "B" Action) by the reviewing agent.

Government approval is required for submittals with a "G" designation. Submittals not having a "G" designation are for information only. When

used, a code following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pad-mounted Transformer Drawings (Fire Pump); G, DO
This and like-named items are for the two oil-filled transformers supplying the powerplant electric fire pump (FPTA and FPTB).

Pad-mounted Transformer Drawings (Offload); G, DO
This and like-named items are for the oil-filled transformer supplying the offload (OTM).

Pad-mounted Transformer Drawings (T442); G, DO
This and like-named items are for the four oil-filled transformers supplying Building 442 (T442A, T442B, T442C, T442D).

SD-03 Product Data

Pad-mounted Transformers (Fire Pump); G, DO

Pad-mounted Transformer (Offload); G, DO

Pad-mounted Transformer (T442); G, DO

SD-06 Test Reports

Acceptance Checks and Tests; G, RO

SD-07 Certificates

Transformer Efficiencies; G, RO

SD-09 Manufacturer's Field Reports

Transformer Test Schedule; G, RO

Pad-mounted Transformer Design Tests; G, RO

Pad-mounted Transformer Routine and Other Tests; G, RO

SD-10 Operation and Maintenance Data

Transformer(s), Data Package 5; G, RO

1.4.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.5 QUALITY ASSURANCE

1.5.1 Pad-Mounted Transformer Drawings

For Pad-mounted Transformer Drawings (Fire Pump), Pad-mounted Transformer Drawings (Offload), and Pad-mounted Transformer Drawings (T442),include

the following as a minimum:

a. An outline drawing, including front, top, and side views.

b. IEEE nameplate data.

c. Elementary diagrams and wiring diagrams with terminals identified of watthour meter and current transformers.

d. One-line diagram, including switch(es), current transformers, meters, and fuses.

e. Manufacturer's published time-current curves in PDF format and in electronic format suitable for import or updating into the EasyPower computer program of the transformer high side fuses.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, except of NFPA 70 when more stringent requirements are specified or indicated, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein. In addition to requirements of Data Package 5, include the following on the actual transformer(s) provided:

a. An instruction manual with pertinent items and information highlighted

b. An outline drawing, front, top, and side views

c. Prices for spare parts and supply list

d. Routine and field acceptance test reports

e. Fuse curves for primary fuses

g. Actual nameplate diagram

h. Date of purchase

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be pad-mounted transformers and related accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.2 THREE-PHASE PAD-MOUNTED TRANSFORMERS

Pad-mounted Transformers (Fire Pump), Pad-mounted Transformer (Offload), and Pad-mounted Transformer (T442), comply with IEEE C57.12.34, IEEE C57.12.28 and as specified herein. Submit manufacturer's information for each component, device, insulating fluid, and accessory provided with the transformer.

The transformers dedicated to the electric fire pump (FPTA and FPTB) shall not be submitted for approval prior to the 21 13 13, 21 13 18, and 21 30 00 hydraulic calculations have been submitted and approved with 'A' or 'B' action supporting an electric fire pump size of 30HP or less. Should the performance calculations yield a fire pump greater than 30HP, provide a 75kVA transformer and adjust protection and conductors accordingly.

2.2.1 Compartments

Provide high- and low-voltage compartments separated by steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

2.2.1.1 High Voltage, Dead-Front

High-voltage compartment contains: the incoming line, insulated high-voltage load-break dead-break connectors, bushing well inserts, feed-thru inserts, six high-voltage bushing wells configured for loop feed application, load-break switch handle(s), access to oil-immersed bayonet

fuses, dead-front surge arresters, tap changer handle, connector parking stands, protective caps, and ground pad.

a. Insulated high-voltage load-break connectors: IEEE 386, rated 15 kV, 95 kV BIL. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector must have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

c. Bushing well inserts and feed-thru inserts: IEEE 386, 200 amperes, 15 kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise.

d. One-piece bushings: IEEE 386, 200 amperes, 15 kV Class.

e. Load-break switch

Loop feed sectionalizer switches: Provide three, two-position, oil-immersed type switches to permit closed transition loop feed and sectionalizing. Each switch must be rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handles in the high-voltage compartment. Operation of switches must be as follows:

ARRANGEMENT NO.	DESCRIPTION OF SWITCH ARRANGEMENT	SWITCH POSITION					
		LINE A SW.		LINE B SW		XFMR. SW	
		OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE
1	Line A connected to Line B and both lines connected to transformer		X		X		X
2	Transformer connected to Line A only		X	X			X
3	Transformer connected to Line Bonly	X			X		X
4	Transformer open and loop closed		X		X	X	
5	Transformer open and loop open	X		X		X	

d. Provide bayonet oil-immersed, expulsion fuses . The bayonet fuse links sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Include an oil retention valve inside the bayonet assembly housing, which closes when the fuse holder is removed, and an external drip shield to minimize oil spills. Display a warning label adjacent to the bayonet fuse(s) cautioning against removing or inserting fuses unless the transformer has been de-energized and the tank pressure has been released.

Bayonet fuse assembly: 150 kV BIL.

Oil-immersed current-limiting fuses: IEEE C37.47; symmetrical current interrupting rating at the system voltage specified.

e. Parking stands: Provide a parking stand near each bushing. Provide insulated standoff bushings for parking of energized high-voltage connectors on parking stands.

f. Protective caps: IEEE 386, 200 amperes, 15 kV Class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushings.

2.2.1.2 Low Voltage

Low-voltage compartment contains: low-voltage bushings with NEMA spade terminals, accessories, metering, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

a. Include the following accessories: drain valve with sampler device, fill plug, pressure relief device, liquid level gage, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator.

2.2.2 Transformer

a. Less-flammable liquid-insulated or oil-insulated, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

b. Refer to sheet EP600 and EP601 for further details, transformer ratings, etc.

c. Tap changer: externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Indicate which tap setting is in use, clearly visible when the compartment is opened.

d. Minimum tested percent impedance at 85 degrees C:

2.50 for units rated 75kVA and below
2.87 for units rated 112.5kVA to 300kVA
4.03 for 500kVA rated units
5.32 for units rated 750kVA and above

e. Comply with the following audible sound level limits:

kVA	DECIBELS (MAX
75	51
112.5	55
150	55

225	55
300	55
500	56
750	57
1000	58
1500	60
2000	61
2500	62

f. Include:

(1) Lifting lugs and provisions for jacking under base, with base construction suitable for using rollers or skidding in any direction.

(2) An insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.

(3) Provide transformer top with an access handhole.

2.2.2.1 Specified Transformer Efficiencies

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. Reference no-load losses (NLL) at 20 degrees C. Reference load losses (LL) at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "KVA / Efficiency" table below. The table is based on requirements contained within 10 CFR 431, Subpart K. Submit certification, including supporting calculations, from the manufacturer indicating conformance.

kVA	EFFICIENCY (percent)
15	98.65
30	98.83
45	98.92
75	99.03
112.5	99.11
150	99.16

225	99.23
300	99.27
500	99.35
750	99.40
1000	99.43
1500	99.48
2000	99.51
2500	99.53
above 2500	99.54

2.2.3 Insulating Liquid

a. Mineral oil: ASTM D3487, Type II, tested in accordance with ASTM D117. Provide identification of transformer as "non-PCB" and "Type II mineral oil" on the nameplate.

2.2.3.1 Liquid-Filled Transformer Nameplates

Provide nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.2.4 Corrosion Protection

Paint entire transformer assembly Munsell 7GY3.29/1.5 green, with paint coating system complying with IEEE C57.12.28 regardless of base, cabinet, and tank material. The Munsell color notation is specified in ASTM D1535.

2.3 WARNING SIGNS AND LABELS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts in accordance with NEMA Z535.4 and NEMA 260.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning labels on the outside of the high voltage compartment door(s)with nominal dimensions of 7 by 10 inches with the legend "WARNING HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. Include the work "WARNING" in white letters on an orange background and the words "HIGH VOLTAGE" in black letters on a white background.

b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "WARNING HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on an orange and black field.

2.4 ARC FLASH WARNING LABEL

Provide arc flash warning label for the enclosure of pad-mounted transformers. Locate this self-adhesive warning label on the outside of the high voltage compartment door warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

2.5 GROUNDING AND BONDING

UL 467. Provide grounding and bonding as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.6 PADLOCKS

Provide padlocks for pad-mounted equipment, keyed alikeas directed by the Contracting Officer. Comply with Section 08 71 00 DOOR HARDWARE.

2.7 CAST-IN-PLACE CONCRETE

Concrete pad must comply with the requirements of Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.8 SOURCE QUALITY CONTROL

2.8.1 Transformer Test Schedule

The Government reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

(1) Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

(2) Accuracy: Traceable to the National Institute of Standards and Technology.

(3) Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.

(4) Dated calibration labels: visible on all test equipment.

(5) Calibrating standard: higher accuracy than that of the instrument tested.

(6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

(a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

(b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.8.2 Design Tests

IEEE C57.12.00, and IEEE C57.12.90. Section 5.1.2 in IEEE C57.12.80 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for the specified transformer(s), with design tests performed prior to the award of this contract.

a. Tests: certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (KNAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests includes the primary windings only of that transformer.

(1) IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

(2) State test voltage levels.

(3) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with IEEE C57.12.34.

e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

f. Short circuit: "Basically the same design" for the short circuit test means a pad-mounted transformer with the same kVA as the transformer specified.

2.8.3 Routine and Other Tests

IEEE C57.12.00. Routine and other tests: performed in accordance with IEEE C57.12.90 by the manufacturer on the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence as follows:

a. Phase relation

b. Ratio

c. No-load losses (NLL) and excitation current

d. Load losses (LL) and impedance voltage

e. Dielectric

(1) Impulse

(2) Applied voltage

(3) Induced voltage

f. Leak

PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 25 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Pad-Mounted Transformer Grounding

Provide a connection to the existing transformer grounding via a 4/0 bare copper conductor to existing transformer grounding. Install the ground rods at least 10 feet apart from each other as required to maintain the required 25 Ohms. Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section

as indicated on project drawings, the approved shop drawings, and as specified herein.

3.4 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.5 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Transformer foundation shall meet the requirements of Section 33 71 02 EXTERIOR ELECTRICAL DISTRIBUTION.

3.6 FIELD QUALITY CONTROL

3.6.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS. Submit reports, including acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

3.6.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

(3) Inspect anchorage, alignment, and grounding.

(4) Verify the presence of PCB content labeling.

(5) Verify the bushings and transformer interiors are clean.

(6) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(7) Verify correct liquid level in tanks and bushings.

(8) Verify that positive pressure is maintained on gas-blanketed transformers.

(9) Perform specific inspections and mechanical tests as recommended by manufacturer.

(10) Verify de-energized tap changer position is left as specified.

(11) Verify the presence of transformer surge arresters.

b. Electrical tests

(1) Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3.6.1.2 Grounding System

a. Visual and mechanical inspection

(1) Inspect ground system for compliance with contract plans and specifications.

3.6.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times of checking and testing.

-- End of Section --

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DIVISION 26 - ELECTRICAL

SECTION 26 13 01

PAD-MOUNTED DEAD-FRONT AIR INSULATED SWITCHGEAR

08/13, CHG 1: 02/20

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ATTACHMENTS:

26 13 01 Attachment 1 - SBIRS PKG C Record Drawings

-- End of Section Table of Contents --

SECTION 26 13 01

PAD-MOUNTED DEAD-FRONT AIR INSULATED SWITCHGEAR
08/13, CHG 1: 02/20

PART 1 GENERAL

Attachments: 26 13 01 Attachment 1 - SBIRS PKG C Record Drawings

1.1 RELATED SECTIONS

Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, applies to this section with the additions and modifications specified herin.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M	(2023) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE 495	(2007) Guide for Testing Faulted Circuit Indicators
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.74	(2014) Standard Requirements for Subsurface, Vault, and Pad-Mounted Load-Interrupter Switchgear and Fused Load-Interrupter Switchgear for Alternating Current Systems Up to 38 kV
IEEE C57.12.29	(2023) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 70B	(2023) Recommended Practice for Electrical Equipment Maintenance

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment

1.3 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING, applies to this section, with the additions and modifications specified herein.

1.4 DEFINITIONS

1.4.1 Switched Way

A switched way is considered a three-phase circuit entrance to the bus through a switch.

1.5 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface". For this Section, any accessories requiring 600V or less station service electrical supply for function of the equipment (controls, actuators, battery chargers, heaters, etc.) shall be included in the CFCI Equipment Electrical Data submittal.

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings; G, DO

SD-03 Product Data

Fuse Time-Current Characteristic Curves; G, DO

Air Insulated Pad-mounted Switchgear; G, DO

Insulated High-Voltage Connectors; G, DO

Surge Arresters; G, DO

SD-06 Test Reports

Acceptance Checks and Tests; G, RO

SD-07 Certificates

Paint Coating System; G, RO

SD-09 Manufacturer's Field Reports

Switchgear Design and Production Tests; G, RO

SD-10 Operation and Maintenance Data

Air Insulated Pad-Mounted Switchgear Operation and Maintenance, Data Package 5; G, RO

1.5.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.6 QUALITY ASSURANCE

1.6.1 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

a. Overall dimensions, weights, plan view, and front view

b. Ratings

c. Single-line diagram.

1.6.2 Paint Coating System

Submit IEEE C57.12.29 paint coating system performance requirement tests.

1.6.3 Fuse Time-Current Characteristic Curves

Provide time-current characteristic curves in PDF format and in electronic format suitable for import or updating into the EasyPower computer program.

1.7 MAINTENANCE

1.7.1 Air Insulated Pad-mounted Switchgear Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 AIR INSULATED PAD-MOUNTED SWITCHGEAR

IEEE C37.74. Submit manufacturer's information on switches and each

component, device, and accessory provided with the equipment.

2.1.1 Ratings and Test Requirements

Provide switchgear with a nominal voltage rating of 15.5 kV and the following corresponding ratings:

Rated Maximum Voltage, kV	15.5
Rated Withstand Impulse Voltage, kV BIL	95
Continuous and Load Interrupting Current, A	600
Short-Circuit Current, kA rms Sym	12.5
Power Fuses, Amperes, Maximum Interrupting, kA rms Sym	200

Provide switched ways rated for the required continuous and load interrupting current.

2.1.2 Switchgear Construction

Provide switchgear with the following construction and configuration:

a. Switch contacts and cable entrance terminations contained in an enclosed, steel compartment.

b. Configured with load interrupting and fused switched ways as indicated.

c. Accessible terminations suitable for cables entering from below.

d. Switch contact positions for switched ways visible through viewing windows in the switchgear termination compartment.

e. Each switched way with two position switch; Open, Closed and provisions for grounding.

2.1.2.1 Pad/Vault-mounting Provisions

Provide enclosed switchgear suitable for installation on a concrete pad or fiberglass box pad, including the following:Provide enclosed switchgear on a concrete vault, as indicated, including the following:

a. Fabricate switchgear enclosure and enclosure base of ASTM A240/A240M type 304 or 304L stainless steel.

b. Enclosure base includes any part of the switchgear enclosure that is within 3 inches of concrete pad.

c. Paint enclosure including base ASTM D1535 Munsell 8.3G6.1/0.5 light gray (ANSI No. 61).

d. Comply with IEEE C57.12.29 for the paint coating system regardless of equipment material.

2.1.3 Load Interrupting Switched Ways

Provide the following for load interrupter switched ways:

a. Three-pole group operated switching.

b. Interrupter switches operated by means of an externally accessible switch-operating hub.

c. Switch-operating hub located within a recessed stainless steel pocket mounted on the side of the pad-mounted gear enclosure.

d. Padlockable stainless steel access cover and hood on the switch-operating-hub pocket to protect the padlock shackle from tampering.

e. Stops on the switch-operating hub to prevent overtravel.

f. Labels in the switch-operating-hub pocket to indicate switch position.

g. Folding switch-operating handle for each interrupter switch.

2.1.4 Fused Ways

Provide the following:

a. Fuse mountings enclosed in an inner steel compartment.

b. Each fuse mounting installed as an integral part of a fuse handling mechanism that does not allow access to the fuse until the elbow for that fuse has been disconnected and a mechanical interlock to the fuse-access panel has been actuated.

c. The opening into the component compartment covered by the fuse-access panel in both the open and closed positions to prevent access to high voltage.

d. Blown-fuse indicators for fused ways visible through viewing windows in the termination compartment.

2.1.4.1 Fuses

Provide fuses in accordance with the following:

a. Fuse ratings as indicated.

b. Helically coiled fuses if rated 10 amperes or larger.

c. Solid-material power fuses capable of detecting and interrupting all faults under all realistic conditions of circuitry, with line-to-line or line-to-ground voltage across the fuse, and capable of handling the full range of transient recovery voltage severity associated with these faults.

d. All arcing accompanying operation of the fuse contained within the fuse, and all arc products and gases evolved effectively contained within the exhaust control device during fuse operation.

e. Fusible elements nonaging and nondamagable with melting time-current characteristics that are permanently accurate to within a maximum tolerance of 10percent in terms of current.

f. Equipped with a blown-fuse indicator that provides visible evidence of fuse operation while installed in the fuse mounting.

2.1.5 Dead-Front High-Voltage Bushings

IEEE 386. 15.5 kV, 95 kV BIL. Provide 600 ampere one-piece deadbreak apparatus bushings for each switched way.

IEEE 386. 15.5 kV, 95 kV BIL. Provide 200 ampere bushing wells and bushing well inserts for each fused way.

a. Parking stands: Provide a parking stand near each dead-front bushing. Provide insulated standoff bushings for parking of energized load-break connectors on each parking stand.

2.2 Insulated High-Voltage Connectors

IEEE 386. Provide corresponding connector for each switched way; provide connectors with a grounding eye and test point.

a. 600 Ampere deadbreak connector ratings: Voltage: 15.5 kV, 95 kV BIL. Short time rating: 25,000 rms symmetrical amperes. Include 200 ampere bushing interface for surge arresters.

b. 200 Ampere loadbreak connector ratings: Voltage: 15.5 kV, 95 kV BIL. Short time rating: 10,000 rms symmetrical amperes.

2.3 Surge Arresters

IEEE C62.11, rated 15 kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Provide arresters on switched ways as indicated.

2.4 Grounding Provisions

Provide a ground-connection pad in each termination compartment.

2.5 Faulted Circuit Indicators

Install one set of faulted circuit indicators on the test points of each set of separable insulated connectors. Faulted circuit indicators must comply with IEEE 495. Indicators must be self powered; with automatic trip with mechanical flag indication upon overcurrent followed by loss of system voltage. Indicators must be compact, sealed corrosion resistant construction with provision for hotstick installation and operation.

2.6 SOURCE QUALITY CONTROL

2.6.1 Switchgear Design and Production Tests

Furnish reports which include results of design and production tests performed according to IEEE C37.74. Perform production tests by the manufacturer on each switchgear assembly to ensure that design performance is maintained in production.

PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 10 ohms. When work, in addition to that indicated or specified, is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.2 Switchgear Grounding

Connect #4/0 bare copper conductor ground loop, not less than 24 inches below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide #4/0 bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

3.2.3 Connections

Make joints in grounding conductors and ground loop by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount switch as shown on the drawings, including the following:

a. Show vault size on the drawings.

b. Provide slab of size at least 12 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 4 inches from the top of the slab.

c. Install top of concrete slab approximately 4 inches above finished grade. Provide edges above grade 1/2 inch chamfer.

d. Provide slab of adequate size to project at least 8 inches beyond equipment.

e. For installations that use a box pad or vault, train the incoming cables around the box or vault prior to terminating at the switchgear.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training areas. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4 FIELD QUALITY CONTROL

3.4.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards. Submit reports, including acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.4.1.1 Switchgear

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Check for proper anchorage, alignment, required area clearances, and grounding.

(4) Perform mechanical operator tests in accordance with manufacturer's instructions.

(5) Inspect all indicating devices for proper operation.

b. Electrical Tests

(1) Perform contact-resistance tests.

(2) Perform insulation-resistance tests.

(3) Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.

3.4.1.2 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) Perform ground impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or

grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.4.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that devices are in good operating condition and properly performing the intended function. Perform each item not less than three times to demonstrate its function. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times for checks and tests.

3.5 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

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METAL-CLAD SWITCHGEAR
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1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D149	(2020) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C37.04	(2018; Erta 2019; Corr 2021) Ratings and Requirements for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000 V Corrigendum 1
IEEE C37.06	(2009) Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities for Voltage Above 1000 V
IEEE C37.09	(2018; Errata 2019; Corr 2021) Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
IEEE C37.20.2A	(2020) Metal-Clad Switchgear Amendment 1: Control and Secondary Circuits and Devices, and All Wiring
IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE C37.20.7	(2017; Corr 2021) Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults
IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C37.90.1	(2013) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers
IEEE C62.11	(2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8500.01	(2014; Change 1-2019) Cybersecurity
DOD 8510.01	(2022) Risk Management Framework (RMF) for DoD Systems

1.2 SYSTEM DESCRIPTION

Items provided under this section must be specifically suitable for the following service conditions. Seismic details must conform to UFC 3-310-04, "Seismic Design for Buildings" and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

a. Altitude 5,663 feet

b. Ambient Temperature 22 - 88 degrees F

c. Frequency 60 Hz

d. Seismic Parameters Design Category C

1.3 SUMMARY

This section describes requirements for controls and switchgear for paralleling generator sets and distributing alternate source power as shown on EP601 for Switchgear USA, USB, GSA, and GSB. Equipment provided shall be new factory assembled paralleling equipment with dedicated purpose microprocessor-based controls designed for fast, reliable operation and including the functions described herein.

1.4 RELATED REQUIREMENTS

Sections 26 08 00 APPARATUS INSPECTION AND TESTING and 25 05 11.05 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - GENERATOR/SWITCHGEAR SCADA apply to this section, with the additions and modifications specified herein.

1. 26 05 73 POWER SYSTEM STUDIES

2. 26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 kW, WITH AUXILIARIES
3. 26 36 23 AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH

1.5 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

ATS: Automatic Transfer Switch
GFP: Ground Fault Protection
HMI: Human-Machine Interface
PLC: Programmable Logic Controller. A device with associated accessory components that is designed to accept programmable inputs and provide completely field-programmable logically controlled outputs.
Manufacturer: The entity that maintains engineering design control for the equipment provided, provides service and maintenance documentation, provides service direction, and provides warranty support.
Supplier: The entity that provides manufacturer-authorized local sales and service support for the manufacturer's equipment.

1.6 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface". For this Section, any accessories requiring 600V or less station service electrical supply for function of the equipment (controls, actuators, battery chargers, heaters, etc.) shall be included in the CFCI Equipment Electrical Data submittal.

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings; G, DO

SD-03 Product Data

Switchgear; G, DO

SD-06 Test Reports

Notice of the Proposed Dates of Factory Inspections and Tests

Factory Test Procedures; G, DO

Switchgear Design Tests; G, DO

Switchgear Production Test; G, DO

Acceptance Checks and Tests; G, DO

SD-07 Certificates

Cybersecurity Equipment Certification; G, HNC

Submit certification indicating conformance with the paragraph CYBERSECURITY EQUIPMENT CERTIFICATION.

Cybersecurity Installation Certification; G, HNC

Submit certification indicating conformance with the paragraph CYBERSECURITY INSTALLATION CERTIFICATION.

SD-10 Operation and Maintenance Data

Switchgear Operation and Maintenance, Data Package 5; G, RO

Generator Controls Sequence of Operations, G, DO

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G, RO

Equipment Test Schedule; G, RO

Request for Settings; G, DO

Service Entrance Available Fault Current Label; G, DO

1.6.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.7 DELIVERY, STORAGE AND HANDLING

a. Deliver paralleling system equipment in section sizes that can be moved past all obstructions in the physical site.

b. All paralleling equipment shall be stored indoors in a temperature controlled environment, in accordance with manufacturer's temporary storage instructions. At a minimum, equipment shall be protected from moisture, dirt, and physical damage.

c. With written approval of the equipment manufacturer, equipment may be stored outdoors, as long as it is protected according to the manufacturer's instructions, including protection from condensation, rain, dust/dirt, and physical damage.

1.8 QUALITY ASSURANCE

1.8.1 Product Data

Include manufacturer's information on each submittal for each component, device and accessory provided with the switchgear including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings.

b. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device.

c. The paralleling equipment manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

d. Source Limitations: The paralleling switchgear shall be designed, manufactured, and warranted by the generator set manufacturer to provide a single source of responsibility for all the products provided. Warranty documents shall be provided verifying compliance to this requirement. Supplier shall directly employ service technicians specifically trained and qualified on the diagnosis and repair of engines, alternators, power transfer equipment, and paralleling equipment. The technicians shall be trained in the installation and commissioning of complex generator systems, including line voltage generator paralleling equipment.

e. The paralleling system, including generator sets and paralleling equipment, shall be serviced by a single local service organization that is trained and factory certified in both generator set and paralleling equipment service. The technicians serving the site shall be specifically trained and certified by the manufacturer in the diagnosis and repair of the synchronizing, paralleling, and load sharing equipment provided. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

f. The manufacturer shall maintain model and serial number records for the paralleling equipment for at least 20 years.

1.8.2 Switchgear Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. The drawings must show adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity on submittal. Also include applicable federal, military, industry, and technical society publication references on submittals. Include the following:

a. One-line diagram including breakers, current transformers, and meters.

b. Outline drawings including front elevation, section views, footprint, shipping splits, rigging plan, and overall dimensions.

c. Bus configuration including dimensions and ampere ratings of bus bars.

d. Markings and NEMA nameplate data including fuse information (manufacturer's name, catalog number, and ratings).

e. Circuit breaker type, interrupting rating, and trip devices, including available settings.

f. Wiring diagrams and elementary diagrams with terminals identified and indicating prewired interconnections between items of equipment and the interconnection between the items.

g. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device. Use this information (designer of record) to provide breaker settings that ensures protection and coordination are achieved.

h. Provisions for future expansion by adding switchgear sections.

1.8.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.8.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for not less than 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.8.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.8.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 1-year prior to date of delivery to site are not acceptable.

1.9 MAINTENANCE

1.9.1 Switchgear Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23OPERATION AND MAINTENANCE DATA.

1.9.2 Assembled Operation and Maintenance Manuals

Assemble and securely bind manuals in durable, hard covered, water resistant binders. Assemble and index the manuals in the following order with a table of contents:

a. Manufacturer's O&M information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA.

b. Catalog data required by the paragraph SD-03, PRODUCT DATA.

c. Drawings required by the paragraph SD-02, SHOP DRAWINGS.

d. Prices for spare parts and supply list.

e. Information on metering.

f. Design test reports.

g. Production test reports.

1.9.3 Spare Parts

A. Provide spare parts as specified below. Provide spare parts that are of the same material and workmanship, meet the same requirements, and are interchangeable with the corresponding original parts furnished.

B. Provide additional items to support the paralleling system equipment, completely programmed and tested, packaged and labeled consistently with designations in system drawings.

1. One set of fuses of each type used in the system.

2. Submit one racking handle(s) with equipment. A charging handle shall be furnished on each breaker mechanism.

3. For all switchgear with circuit breakers in upper compartments, provide one circuit breaker lifting device.

C. Maintenance tools: Furnish tools and miscellaneous items required for system inspection, monitoring, maintenance, and operation. Tools shall be provided for the system shall include:

1. Any non-standard tools for mechanical maintenance on the system. This includes items such as circuit breaker racking wrenches and special engine tools.

1.10 WARRANTY

Provide equipment items that are supported by service organizations reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis

during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

All equipment specified within this section and Section 26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILARIES, are to be provided by Cummins Power Generation as a complete system. Equipment specifications for this section are based on microprocessor-based paralleling equipment manufactured by Cummins Power Generation

Products and materials not considered to be switchgear and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 GENERATOR PARALLELING MONITOR AND CONTROL SYSTEM

2.2.1 Ratings

A. Stationary Structure

1. The switchgear shall consist of vertical sections including breaker compartments and auxiliary compartments assembled to form a rigid self-supporting completely enclosed structure providing steel barriers between sections per sheet EP201.

2. The sections are divided by metal barriers into the following separate compartments:
Circuit breaker, instrument, main bus, auxiliary device and cable.
Each feeder section may have up to two circuit breaker compartments.

B. Circuit Breaker Compartment

1. Each circuit breaker compartment shall be designed to house a horizontal drawout metal-clad vacuum circuit breaker. The stationary primary disconnecting contacts are to be silver-plated copper and mounted within porcelain support bushings. The movable contacts and springs shall be mounted on the circuit breaker element for ease of inspection/maintenance.

2. Entrance to the stationary primary disconnecting contacts shall be automatically covered by metal shutters when the circuit breaker is withdrawn from the connected position to the test or disconnected position or removed from the circuit breaker compartment. Extend a ground bus into the circuit breaker compartment to automatically ground the breaker frame with high-current spring type grounding contacts located on the breaker chassis when in the test and connected positions. Guide rails for positioning the circuit breaker and all other necessary hardware are to be an integral part of the circuit breaker compartment. Blocking devices shall interlock breaker frame sizes to prevent installation of a lower ampere rating or interrupting capacity element into a compartment designed for one of a higher rating. It shall be possible with indoor or outdoor walk-in switchgear to install a circuit breaker into a bottom compartment without use of a transport truck or lift device.

C. Cable Compartment/Ground Bus

1. Cable terminators shall be furnished as shown on plans. The ground bus shall extend through this compartment for the full length of the switchgear. Auxiliary bus, if needed, and load bus support NEMA Class A-20 standoff insulators shall be epoxy.

D. Main Bus Compartment

1. The main bus is to be rated 1200 amps and be fully insulated for its entire length with an epoxy coating by the fluidized bed process. The conductors are to be silver-plated copper and be of a bolted design. Access to this compartment is gained from the front or rear of the structure by removing a steel barrier. Provide standard provisions for future extension, as applicable.

E. Doors and Panels

1. Relays, meters, control switches, etc., shall be mounted on a formed front-hinged panel for each circuit breaker compartment.

F. Circuit Breakers

1. The circuit breakers shall be rated 13.2KV nominal volts, 15000 maximum volts, 60 Hz, with a continuous current rating of 1200 amps and a maximum symmetrical interrupting rating of 25kA/500MVA - 15 kV system. Furnish Type VR circuit breakers with one vacuum interrupter per phase. Breakers of same type and rating shall be completely interchangeable. The circuit breaker shall be operated by means of a stored energy mechanism which is normally charged by a universal motor but can also be charged by the manual handle supplied on each VR breaker for manual emergency closing or testing. The closing speed of the moving contacts is to be independent of both the control voltage and the operator. Provide a full front shield on the breaker. Secondary control circuits shall be connected automatically with a self-aligning, self-engaging plug and receptacle arrangement when the circuit breaker is racked into the connected position. Provision shall be made for secondary control plug to be manually connected in test position. A minimum of 4 auxiliary contacts (2a 2b), shall be provided for external use. Provisions shall be made for 10 additional cell-mounted auxiliary contacts both MOC and TOC type for external use. The racking mechanism to move the breaker between positions shall be operable with the front door closed and position indication shall be visible with door closed.
* Maximum symmetrical kA interrupting ratings are based on Table 1 of C37.06-1997. MVA ratings are nominal reference values for comparison only.

2. An interlocking system shall be provided to prevent racking a closed circuit breaker to or from any position. An additional interlock shall automatically discharge the stored-energy operating mechanism springs upon removal of the breaker out of the compartment.

3. The circuit breaker control voltage shall be 125VDC.

G. Instrument Transformers

1. Current transformers: Each breaker compartment shall have provision for front-accessible mounting of up to four current transformers per phase (ANSI standard relay accuracy), two on bus side and two on cable side of circuit breaker. The current transformer

assembly shall be insulated for the full voltage rating of the switchgear. The current transformers wiring shall be Type SIS #12 AWG. Relaying and metering accuracy shall conform to ANSI Standards.

2. Voltage transformers are drawout mounted with primary current-limiting fuses and shall have ratio as indicated. The transformers shall have mechanical rating equal to the momentary rating of the circuit breakers and shall have metering accuracy per ANSI Standards.

H. Control Wiring

1. The switchgear shall be wired with type SIS #14 AWG, except where larger size wire is specified. The switchgear shall be provided with terminal blocks for outgoing control connections. Wire markers shall be provided for each end of all control wires.

I. Protective Relays

Provide relays as indicated on drawings for each circuit breaker Refer to section 2.3.3 for further details.

2.2.2 Construction

A. Construction: Each equipment bay shall be a separately constructed cubicle assembled to form a rigid freestanding unit. Minimum sheet metal thickness shall be 11 gauge steel on all exterior surfaces. Adjacent bays shall be securely bolted together to form an integrated rigid structure. The rear covers shall be removable to assist installation and maintenance of bus and cables. Each individual unit shall be braced to prevent distortion.

B. Dimensions: Standard dimensions per indoor section are: 36 in W x 95 in H x 92/100 in D Outdoor equipment dimensions will vary with enclosure style and circuit breaker selection. Maximum height shall be 109 in for non-walk-in style enclosure, measured to peak of the sloped roof.

C. The metal-clad switchgear shall be fully assembled, inspected, and tested at the factory prior to shipment. Large line-ups shall be split to permit normal shipping and handling as well as for ease of rejoining at the job site.

D. All steel parts, except galvanized (if used), shall be cleaned and a zinc-phosphate (outdoor equipment) or iron phosphate (indoor equipment) pre-treatment applied prior to paint application.

E. Paint color shall be ANSI-61 light grey; TGIC polyester powder, applied electrostatically through air. Following paint application, parts shall be baked to produce a hard durable finish. The average thickness of the paint film shall be 2.0 mils. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling.

F. Adequacy of paint finish to inhibit the buildup of rust on ferrous metal materials shall be tested and evaluated per paragraphs 5.2.8.1-7 of ANSI C37.20.2-1987. Salt spray withstand tests in accordance with ASTM #D-1654 and #B-117 shall be performed on a periodic basis to provide conformance with the corrosion resistance standard of at least 2500 hours minimum (outdoor equipment) or 600 hours minimum (indoor

equipment).

2.2.3 Individual Generator Monitoring And Control Panel

A. Provide a paralleling control panel for each generator set in the emergency/standby power system. The paralleling control functions shall be integrated with the generator set control functions, and provided in a single, dedicated purpose microprocessor-based control designed and manufactured by the generator set manufacturer. Each paralleling control panel shall contain the functions as described in this section. No PLC-based control shall be used to provide these functions. Each paralleling control shall be independent and autonomous, requiring no interaction with other controls for proper operation, except load sharing and paralleling breaker status functions. Failure of the system master control shall have no impact on the functions described in this section for the generator sets.

1. The control shall be designed for proper operation without recalibration in ambient temperatures from -40 ºC (-40 ºF) to +70º C (158 ºF), and for storage from -55 ºC (-67 ºF) to +80 ºC (176 ºF). Control will operate with humidity up to 95%, non-condensing.

2. The HMI shall be designed for proper operation in ambient temperatures from -20 ºC (-4 ºF) to +70 ºC (158 ºF), and for storage from -30 ºC (-22 ºF) to +80 ºC (176 ºF). The control board shall be fully encapsulated to provide superior resistance to dust and moisture. Display panel shall have a single membrane surface, which is impervious to effects of dust, moisture, oil and exhaust fumes. The panel shall use a sealed membrane to provide long reliable service life in harsh environments. The control system shall be specifically designed and tested for resistance to RFI/EMI and to resist effects of vibration to provide a long reliable life when mounted on a genset. The control shall include transient voltage surge suppression to provide compliance to referenced standards.

3. Each paralleling control shall be provided with an operator panel to allow the operator to view the status and control operation of the specific generator set being paralleled. The operator panel shall be provided with the following features and capabilities

a. The control shall include an option to provide both a local and remote operation panel.

b. The control shall provide comprehensive three phase AC metering functions for the generator set and an additional source, including: 3-phase voltage (L-L and L-N) and current, frequency, phase rotation, individual phase and totalized values of kW, kVAR, kVA and Power Factor; totalized positive and negative kW-hours, kVAR-hours, and kVA-hours. Three wire or four wire voltage connection with direct sensing of voltages to 600V, and up to 45kV with external transformers. Current sensing is accomplished with either 5 amp or 1 amp CT secondaries and with up to 10,000 amp primary.

c. Running Time Meter, Start Counter.

d. Four tactile feel membrane switches shall be included to control auto mode, stop/off, manual mode, and manual start.

e. Two tactile feel membrane switches dedicated to control of

circuit breaker shall be included.

f. One tactile feel membrane switch shall be provided for fault reset.

g. One tactile feel membrane switch shall be provided to test panel lamps. Operation of this switch shall cause all lamps on the panel to be simultaneously tested.

h. The control panel shall be provided with a set of DC-powered lamps with a switch to allow viewing of all functions on the front panel when normal lighting systems are not available.

i. Emergency Stop Switch. The emergency stop switch shall be a red, mushroom head switch which maintains its position until manually reset. Emergency Stop Switch to have a plastic hinged cover or glass break cover to prevent accidental pressing of the Emergency Stop Switch.

j. Precision voltage and frequency adjust raise/lower switches. Switches shall allow the generator set frequency and voltage to be adjusted plus or minus 5% when the generator set is operating independently of the system bus. The switches shall be disabled when the paralleling breaker is closed. Voltage and frequency adjustments while the paralleling breaker is open shall not impact on the load sharing when the paralleling breaker is closed.

k. The control shall support the following languages (Minimum): English.

l. Alarm and status indicating panel to indicate the following conditions (alarm horn shall be located on master control):

Function	Lamp Color	Alarm Horn	Shutdown Unit
Low DC Voltage	Amber	*	
High DC Voltage	Amber	*	
Weak Battery	Amber	*	
Failure to Sync	Amber	*	
Low Oil Pressure Alarm	Amber	*	
Low Fuel - Daytank	Amber	*	
High Engine Temp Alarm	Amber	*	
Ground Fault	Amber	*	
Overcurrent Alarm	Amber	*	
Breaker Failure	Red	*	*
Breaker Tripped	Red	*	*
Not in Auto	Red	*	*
High Engine Temp	Red	*	*
Low Oil Pressure	Red	*	*
Overcurrent	Red	*	*
Short Circuit	Red	*	*
Loss of Excitation	Red	*	*
Reverse Power	Red	*	*
Overcrank	Red	*	*
Overspeed	Red	*	*
Under Frequency	Red	*	*
Under Voltage	Red	*	*
Over Voltage	Red	*	*
Phase Rotation	Red	*	*
Low Coolant Level	Red	*	*
Automatic	Green		
Generator Running	Green		
Breaker Open	Green		
Breaker Closed	Green		
Demand Mode Standby	Green		
Timing for Start	Green		

Function	Lamp Color	Alarm Horn	Shutdown Unit
Timing for Shutdown	Green		

B. Internal Controls. The following internal control functions shall be provided for each generator set control in the system.

1. The control shall include a synchronizer to electronically adjust the engine governor to match the voltage, frequency and phase angle of another source such as another generator set(s) or the utility grid. Synchronizer shall maintain the engine generator voltage within 0.5 - 10% (adjustable) of bus voltage and phase angle within 0.1 - 20 electrical degrees (adjustable) of the bus for 0.5 - 5 seconds (adjustable) before circuit breaker closing. The synchronizer shall include provisions to provide proper operation even with highly distorted bus voltage waveforms. The synchronizer can match other sources over a range of 60-110% of nominal voltage and -24 to +6 hertz. The system shall be provided with a fail to synchronize time delay that is adjustable from 10-900 seconds. Control logic for fail to synchronize function shall allow field adjustment of function for either alarm or shutdown of the generator set on failure condition. Each unit shall have its own synchronizer; systems using a switching scheme to utilize a single system synchronizer will not be approved. Synchronizers and systems which utilize a motor driven pot for control of AC voltage during the synchronizing process will not be accepted.

2. Controls shall include a sync check function to prevent accidental closure of the paralleling breaker with the generator set out of phase with the bus. Provisions to allow closure of the first generator set to a de-energized bus shall be included. Adjustable criteria are for the sync check function shall be: phase difference from 0.1-20 degrees, frequency difference from 0.001-1.0 Hz, voltage difference from 0.5-10%, and a dwell time from 0.5-5.0 seconds. The sync check function should ensure that generator set phase rotation matches bus phase rotation. Internally the sync check shall be used to confirm synchronization prior to performing closed transition operations. An external sync check output is also available. The sync check function shall operate in both the automatic and manual mode of the generator set control.

3. Electronic isochronous kW load sharing control to operate the engine governors during synchronizing and to provide isochronous load sharing when paralleled. The control system shall allow sharing of real kW load between all generator sets in the system to within 1% of equal levels, without introduction of frequency droop into the system. The control system shall include all equipment required for kW load sharing with an isolated bus. Electronic kVAR load sharing control shall operate the alternator excitation system while the generator set is paralleled. The control system shall allow sharing of reactive load between all generator sets in the system to within 1% of equal levels, without introduction of voltage droop into the system. The isochronous load sharing module shall be integral function of the generator control.

4. When the generator set control receives a signal indicating that

the genset is paralleled with an infinite source such as a utility (mains) service, the genset shall operate in load govern mode. Control shall be adjustable for kW values from 0-100% of standby rating, and 0.7-1.0 power factor (lagging). The control shall include inputs to allow independent control of kW and kVar load level by a remote device while in the load govern mode. The rate of load increase and decrease shall also be adjustable in the control.

5. Load demand governing controls shall be provided to cause the generator set to ramp down to zero load when signaled to shut down in a load demand mode. On a signal to re-start, the load demand governing controls shall cause the generator set to synchronize to the system bus, close, and ramp up to its proportional share of the total bus load. The ramp rate of the generator set shall be operator-adjustable.

6. The control shall include a first start function to monitor all of the generator sets as they are starting to positively prevent out of phase paralleling if two or more engine generator sets reach operating conditions simultaneously. The control shall provide a lockout signal to disable breaker closure for generator set(s) in the system which have not been selected to be the first units to close to the bus. The control shall verify that the generator set has reached at least 90% of nominal voltage and frequency before closing to the bus. Controls shall recognize a failure of the first breaker signaled to close and allow system operation to proceed in spite of this failure. The first start function shall be integral to each generator set control and failure of any generator set control shall not affect the first start functionality of the other controls in the system. Systems using dead bus relay schemes without a disable signal to positively prevent out of phase paralleling shall not be acceptable under this specification. Systems that provide an independent PLC to perform this function shall not be acceptable. System shall include an independent backup to automatically operate in the event that the primary system fails.

7. The control shall include an integrated three phase line-to-line sensing voltage regulation system that is compatible with shunt or PMG excitation systems. The voltage regulation system shall be three phase full wave rectified and have a FET output for good motor starting capability. Major system features shall include: Digital output voltage regulation - Capable of regulating output voltage to within +/-1.0% for any loads between no load and full load. Voltage drift shall not exceed +/-1.5% for a 40 ºC (104 ºF) change in temperature in an eight hour period. On engine starting or sudden load acceptance, voltage shall be controlled to a maximum of 5% overshoot over nominal level.

8. The control shall include an integrated isochronous governing system capable of controlling engine speed within +/-0.25% for any steady state load from no load to full load. Frequency drift shall not exceed +/-0.5% for a 33 °C (60 °F) change in ambient temperature over an 8 hour period. The control shall include temperature dependent governing dynamics that will modify the engine governing control parameters as a function of engine temperature.

9. Masterless Load Demand: The control shall offer the capability for generator sets to share essential information regarding the current systems load and available system capacity in isolated bus

paralleling topology. All generator sets in this mode shall be capable of autonomously starting and stopping based on dynamic analysis of real power (kW) system load versus demand, such that in the event that total capacity is above the specified load set point then generator sets can be shutdown to avoid unnecessarily providing surplus capacity, whereas by contrast in the event that total capacity is below the specified load set point then generator set can be started to provide the required additional capacity per load needs. The priority for generator set starting and shutdown can be set either by the operator or be based upon the number of generator set run hours. Integrated on-board system logic provides the MLD topology control without the need for any additional system.

10. The control shall include a derate function to reduce output power of the genset in response to a fault condition. If a derate command occurs while operating on an isolated bus, the control shall issue commands to reduce the load on the genset via contact closures or Modbus. If a derate command occurs while in utility parallel mode, the control shall actively reduce power by lowering the base load kW to the derated target kW.

11. The control shall provide a load shed signal when the generator set overloaded or in an under frequency condition. The overload parameters shall be adjustable from 80%-140% of generator kW rating for more than 0-120 seconds. The frequency parameters shall be adjustable from 0.1-10Hz under nominal frequency for more than 0-20 seconds.

12. The control shall accept up to four alarm or status inputs to indicate a configurable (customer-specified) condition. The inputs shall be programmable for warning, derate, shutdown, shutdown with cooldown or status indication and for labeling the input.

13. The control in conjunction with InPower software, shall accept commands to allow a technician to verify the proper operation of the control and its interface by simulating failure modes or by forcing the control to operate outside of its normal operating ranges.

14. The control shall include provisions for utility and genset breaker interfaces including separate relays for opening and closing the respective breaker, as well as inputs for both 'a' and 'b' breaker position contacts and tripped status. Breaker diagnostics shall include contact Failure, fail to close, fail to open, fail to disconnect, and tripped. Upon breaker failure, appropriate control action shall be taken to maintain system integrity.

15. The control shall provide adjustable start delay from 0-300sec, stop delay from 0-800sec, transfer delay from 0-120sec, retransfer delay from 0-1800sec, programmed transition delay from 0-60sec, and maximum parallel time from 0-1800sec

16. Cooldown time delay, adjustable: 0-600 seconds. The control panel shall indicate the time remaining in the time delay period when the generator set is timing for shutdown.

17. Control equipment shall contain a system of diagnostic LED's to assist in analyzing proper system function.

C. Generator Set Protection - The control shall include the protective

functions listed below. On operation of a protective function the control shall indicate a fault by illuminating the appropriate status LED on the HMI, as well as display the fault code and fault description on the HMI display screen. The nature of the fault and time of occurrence shall be logged in the control.

1. The control shall include a Maintenance Mode that will provide the capability to instantaneously shutdown the generator set to reduce the risk of Arc Flash due to thermal overload or electrical faults by inverse time protection.

2. Reverse power shutdown (32) - Controls shall be provided to sense reverse power conditions on the engine while paralleled to the system bus. Reverse power protection shall be set to operate at not more than 20% of the kW rating of the generator set at standby conditions. Adjustment range: 5-20% of standby kW rating, delay 1-15 seconds. Default: 10%, 3 seconds.

3. Reverse Var shutdown - Controls shall be provided to sense reverse var conditions on the alternator while paralleled to the system bus. Reverse Var protection shall be set to operate at not less than 15% of the kVAR rating of the alternator at standby conditions. A reactive capability curve shall be provided to allow proper setting of this protection. Shutdown level is adjustable: 15-50% of rated Var output, delay 10-60 seconds.

4. Overcurrent warning/shutdown (51) - Electronic alternator overcurrent alarm and shutdown protection. This protection shall be required in addition to the overcurrent trip on the paralleling breaker, and shall sense current flow at the generator set output terminals. The overcurrent alarm shall be indicated when the load current on the generator set is more than 110% of rated current for more than 60 seconds. The overcurrent shutdown shall be matched to the thermal damage curve of the generator set, and shall not have an instantaneous function.

5. Short circuit protection - This protection is in addition to the overcurrent trip on the paralleling breaker. The short circuit shall occur when the load current on the generator set is more than 175% of rated current and an aggregate time/current calculation indicates that the system is approaching the thermal damage point of the alternator. The equipment used shall not have an instantaneous function and shall be selectively coordinated with the feeder circuit breakers. Control shall include algorithms to protect alternator from repeated over current conditions over a short period of time.

6. Current Regulation - A UL-listed comprehensive monitoring and control system shall be integral to the generator set control that guards the electrical integrity of the alternator and power system by providing protection against a wide array of fault conditions in the genset or in the load. The current regulation control system shall provide single and three phase fault current regulation so that downstream protective devices have the maximum current available to quickly clear fault conditions without subjecting the alternator to potentially catastrophic failure conditions. The control shall provide overcurrent and short circuit protection for the conductors connecting the generator set to the paralleling switchgear. This protection may be integrated with alternator protection but must be positively coordinated to prevent tripping of the paralleling breaker

prior to the operation of the alternator protective equipment.

7. Controls shall be provided to regulate output current on any phase to a maximum of 3 times rated current under fault conditions for both single phase and three phase faults. In conjunction with a permanent magnet generator, it shall provide 3 times rated current on all phases for motor starting and short circuit coordination purposes.

8. High AC voltage shutdown (59) - Controls shall be provided to shut down generator set and initiate alarm when the generator set output voltage on any phase exceeds preset values. Time to trip is inversely proportional to amount above threshold. Values adjustable from 105-125% of nominal voltage, with time delay adjustable from 0.1-10 seconds.

9. Low AC voltage shutdown (27) - Controls shall be provided to shut down generator set and initiate alarm when the generator set voltage on any phase has dropped below a preset value. Adjustable over a range of 50-95% of reference voltage, time delay 2-20 seconds. Function tracks reference voltage. Control does not nuisance trip when voltage varies due to the control directing voltage to drop, such as during a V/Hz roll-off or synchronizing.

10. Under frequency shutdown (81 u) - Controls shall be provided to shut down generator set and initiate alarm when the generator set output frequency cannot be maintained. Settings are adjustable from 2-10 Hz below reference governor set point, for a 5-20 second time delay. Under frequency protection is disabled when excitation is switched off, such as when engine is operating in idle speed mode.

11. Over frequency shutdown/warning (81o) - Controls shall be provided to shut down generator set and initiate alarm when the generator set is operating at a potentially damaging frequency level. Settings are adjustable from 2-10 Hz above nominal governor set point for a 1-20 second time delay.

12. Low and high battery voltage warning - The control shall indicate status of battery charging system (failure) by continuously monitoring battery voltage.

13. Weak battery warning - The control shall test the battery each time the genset is signaled to start and indicate a warning if the battery indicates impending failure.

2.2.4 Master Control System And Monitoring Equipment

Provide an independent system master control to monitor and control the operation of the entire paralleling system. Each panel shall contain the components and devices as described in this section.

A. Construction

1. The Master Control should be housed either fully incorporated into the switchgear or housed separately in a standalone enclosure.

2. The enclosure frame shall be welded and constructed of a minimum of 12 gauge steel. Covers shall be constructed of a minimum of 16 gauge steel.

3. The enclosure shall be painted smooth ANSI 61 Gray and the interior subpanels shall be full height of the enclosure, constructed of a minimum 12 gauge unpainted galvanized conductive steel. The enclosure should allow for baying as necessary to house all the necessary components for the Master Control.

4. All doors and covers shall have foam-in-place urethane gaskets.

5. The enclosure shall be a design to allow top lifting with lifting eyes.

6. The enclosure shall include a lockable door handle which operates a three-point latching system, with a minimum of two keys provided.

7. The enclosure shall be NEMA 1.

8. All interior panels and doors shall be bonded to the grounding bar.

9. The master control system shall be listed and labeled under the requirements of UL 891, including all covers, barriers, and supports. Individual control sections shall be isolated from each other by metal or insulating barriers.

10. All wiring shall be UL listed 105 degree C, 600 volt rated, and sized as required. Each wire, device or function shall be suitably identified by silk screen or similar permanent identification.

11. AC control circuits in the switchboard shall be protected with properly sized miniature circuit breakers. Potential transformers shall be protected on line and load side.

12. All CT installations shall include shorting type terminal blocks.

13. All field control interconnecting wiring shall be sized as specified by system manufacturer (wiring not designated by the system manufacturer shall be minimum 14 AWG copper). All control interconnect wiring shall be stranded.

14. All active control system components in the system shall be suitable for operation in ambient temperatures ranging from 0 to +60 degrees C. The active control electronics shall be environmentally protected from dust, dirt, and humidity. The controls shall be suitable for operation in an ambient ranging from 5-95% relative humidity, and shall be protected from the effects of equipment vibration.

15. The Touchscreen and other non-LED displays specified shall be suitable for operation from 0 to +50 degrees C. The controls shall be suitable for operation in an ambient ranging from 10-90% relative humidity.

B. Additional Components Required

1. A door operated 24VDC LED light connected to the best battery system shall be provided to allow for troubleshooting when normal lighting systems are not available.

2. Service ports that allows a PC, mouse, keyboard, and mass storage

media connection to the interior control components without needing to open the enclosure door during regular operation, maintenance and service.

3. An alarm horn with a red flashing LED light shall be provided with sound level at least 90 db at 10cm pulsing.

C. Main Controller

1. The Main controller of the Master Control shall be a Programmable Logic Controller (PLC).

Acceptable Manufacturers are:
a) Rockwell Aitomation

2. The PLC shall use a non-volatile memory to store the program, constants, symbols, comments, and data and shall not require a battery that requires regular maintenance. (Remove for Redundancy option)

3. The PLC and associated I/O components shall have the following minimum specifications:
a) 0-60 degree C operating temperature
b) -40 to 85 degree C storage temperature
c) 19Vdc to 30Vdc operating voltage
d) LED diagnostics for troubleshooting.

4. The PLC shall use primarily a distributed I/O configuration to reduce the amount of interconnect wiring.

5. Redundant PLC CPU shall be supplied with a bump less transfer when the primary CPU has a failure. The configuration shall be of a synchronized Hot-standby. The backup PLC CPU shall be housed in its own rack with a segregated power supply from the primary PLC CPU. The failure of one CPU should not have any effect on the distributed I/O racks nor any loss of data.

6. Redundant PLC I/O shall be supplied so that each I/O point in the system has a primary and backup connection to the PLC. The primary and backup shall be in separate I/O racks and shall not share the same in rack power supply.

7. Redundant in-Rack Power Supplies shall be provided in each and every PLC rack in the Master Control. The redundant supplies must not be supplied by the same circuit but should be supplied by separate branch circuits.

8. PLC languages used shall comply with IEC 61131. The Primary code language for the sequence of operation shall be Sequential Function Chart.

9. The PLC programming software shall automatically keep track of each change by recording the build version. This version shall be available on the diagnostics screen in the HMI

10. The PLC programming software vendor shall maintain additional tools to allow for the ability to automatically and graphically display the differences between two program versions.

11. The PLC I/O shall be primarily of a distributed I/O architecture

with the I/O placed as close as possible to the device being controlled to limit the amount of interconnect wiring and reduce field wiring mistakes. Typically this would consist of the I/O being mounted on a din rail in the switchgear enclosure.

12. The PLC I/O network shall be a self-healing Ethernet ring network, where any cable break will not interrupt communications between the PLC and the I/O communication module. Diagnostic information shall be located on the diagnostics screen in the HMI to graphically indicate where any cable breaks and communication failures have occurred.

D. Operator Panel

1. The Operator Panel shall be constructed of two parts: a Touchscreen and an Industrial PC.

a) Both the Touchscreen and Industrial PC shall have separate isolated 24VDC power supplies.

b) The Touchscreen shall be constructed so that it can be replaced without any program modifications, licensing, or software tools.

c) The Touchscreen shall have an aluminum bezel and be a resistive touch 19 inch SXGA TFT LCD LED backlight with 1280x1024 resolution.

d) The Industrial PC shall be of a panel mount construction.

e) The Industrial PC shall have the following specifications and shall not have any moving parts such as fans or spinning media drives:

i. 32GB Solid State Hard Disk Drive
ii. Windows 7 embedded
iii. 2: 10/100/1000 Base T RJ45 ports
iv. 6: USB 2.0 Ports
v. 9-35VDC power supply

2. One of the Ethernet ports on the Industrial PC shall be dedicated for customer interface to the web server and building management system interface.

2.2.5 Operator Screens

A. The Operator Screens shall be constructed so that every main screen is within one click of each other. A common navigation bar should be available so that any screen can be accessed from another screen without the need to return to a main menu. The Screen Navigation buttons shall be graphical in nature and indicate visually whether the screen is available to be selected, is unselected, or is selected.

B. The operator screens shall have visual indication of new and active alarms as well as the number of active alarms on every screen. The active alarm log screen shall be within one click from any other screen.

C. Operator Help Screens shall be available on every screen with screen specific content.

D. The Security Log-in/Log out screens shall be available from every

screen.

E. The current System Operating Mode shall be displayed on every screen.

F. Oneline Diagram: The Oneline Diagram shall display graphical indication of all Power System components monitored by the Master Control, including:

1. Generator State (Running, Not Running)

2. Generator Mode (Auto, Manual, Start Pending, Running, Cooldown, Load Demand Stop)

3. Generator Fault (Warning, De-rate, Shutdown)

4. Breaker States (Open, Closed, Racked Out, Failed, Unknown. Manual)

5. Breaker Type (Fixed Mount, Drawout).

6. All Loads assigned to the Load/Add shed sequence shall display the levels to which the load is assigned

7. Bus Status (Hot, Cold, Unknown)

8. Feeder Breakers shall have the ability to open and close by pressing the breaker symbol to open a control window for operator initiated open and close.

9. Automatic Transfer Switches shall show status of the switch as well as the source status when available.

10. For projects that have a utility breaker the following additional parameters shall be shown:

a)Utility Status (Live, Failed, unknown)
b)Retransfer Time Delay Countdown
c)Authorized Utility Return Status
d)Source Synchronizing Status

11. The Power System device names shall be field editable with the right credentials to suit customer specific device names and shall not require programming software to do so.

12. Average Voltage and Power for each source shall be displayed.

G. The Generator Summary Screen shall display generator state, status, and all engine and alternator parameters including at a minimum the following:

1. Generator Control Switch Position

2. Generator State

a)Stopped
b)Start Pending
c)Warmup at Idle
d)Running
e)Cool down at rated
f)Cool down at idle

3. Generator Common Warning

4. Generator Shutdown

5. Load Demand Stop

6. Circuit Breaker Position

a)Open, Closed, disconnected, Unknown, Failed

7. Engine Data

a)Engine Speed
b)Oil Pressure
c)Coolant Temperature
d)Battery Voltage
e)Engine Runtime
f)Number of Starts
g)Kilowatt Hours
h)Fuel Rate
i)Total Fuel Used

8. Alternator Data

a)Line to Line Voltage
b)Line to Neutral Voltage
c)Current
d)Frequency
e)Power Factor
f)Total kW
g)Percent kW
h)Total kVA
i)Total kVAR

9. Paralleling Bus Data

a)Line to Neutral Voltage
b)Line to Line Voltage
c)Frequency

10. Annunciator Points

a)Common Alarm
b)Genset Supplying Load
c)Genset Running
d)Not in Auto
e)High Battery Voltage
f)Low Battery Voltage
g)Charger AC Failure
h)Failed to Start
i)Low Coolant Temperature
j)Pre High Engine Temperature
k)High Engine Temperature
l)Pre Low Oil Pressure
m)Over Speed
n)Low Coolant Level
o)Low Fuel Level

11. Analog Gauges shall be available and the gauge range shall be field adjustable without additional programming software.

a)Power
b)Average Voltage Line to Line
c)Average Current
d)Frequency
e)Oil Pressure
f)Coolant Temperature
g)Engine Speed
h)Battery Voltage

12. Manual Generator Control

a)Start
b)Stop
c)Fault Reset

13. Paralleling Breaker Control

a)Open
b)Close

H. Metering Screen

1. The metering screen shall display system metering data at a minimum for all source breakers. The metering shall be a minimum of 1% accurate for voltage and current measurements.

2. The following data shall be displayed.

a)Voltage Line to Line (Phase)
b)Voltage Line to Line (Average)
c)Voltage Line to Neutral (Phase)
d)Voltage Line to Neutral (Average)
e)Current (Phase)
f)Current (Average)
g)Frequency
h)Real Power (Phase)
i)Real Power (Average)
j)Reactive Power (Phase)
k)Reactive Power (Average)
l)Apparent Power (Phase)
m)Apparent Power (Average)
n)Power Factor (Average)
o)KW Hours Import (Total)
p)KW Hours Export (Total)
q)KVAR Hours Import (Total)
r)KVAR Hours Export (Total)

3. Analog Gauges should be available for the following parameters. The range shall be field adjustable for min and max. The gauges shall be available in two sizes.

a)Real Power (kW)
b)Average Voltage Line to Line
c)Average Current
d)Frequency

I. Trending Screen

1. The Trending Screen shall display the historical data log information from the database. The data log rate shall log parameter data as it changes and should not exceed a 2 second log rate.

2. The trending graph shall be able to display up to 8 simultaneous pens. Each pen to represent a different data point on the graph.

3. The trending graph shall allow for each parameter being logged to be displayed at any one time and not be limited to trend "groups", or limited to a single simultaneous device.

4. The graph scale shall be adjustable for time as well as for each parameter's y axis.

5. The Trend shall be able to be paused and then re-started without any loss of data.

6. The available trend information shall be for the previous 90 days at a minimum in a FIFO format.

7. The Trend data shall be available for export to a USB media drive in a .CSV file format.

8. The following Parameters shall be available for Trending:
 a)Generator Data
  i. Average Voltage Line to Line
  ii. Average Voltage Line to Neutral
  iii. Average Current
  iv. Percent kW
  v. Total kW
  vi. Total kVAR
  vii. Total KVA
  viii. Frequency
  ix. Power Factor
  x. Battery Voltage
  xi. Oil Pressure
  xii. Oil Temperature
  xiii. Coolant Temperature
  xiv. Engine RPM
  xv. Fuel Rate
 b)Meter Data
  i. Average Voltage Line to Line
  ii. Average Voltage Line to Neutral
  iii. Average Current
  iv. Total kW
  v. Total kVAR
  vi. Total KVA
  vii. Frequency
  viii. Power Factor

J. System Control Screen

1. The System Control Screen shall be the screen where all operator initiated functions are started and stopped.

2. The System Control functions include:

a)Transition Type Selection
b)Time Delay Adjustments
c)System Mode Adjustments

K. Load Control Screen

1. The Load Control Screen shall allow for load level configuration for each load. Each load should be able to be assigned to a configurable load add and load shed level.

2. The Shed levels should be allowed to be automatically assigned according to the order of the assigned add level, or if desired be operator customized.

3. Each Load shall be able to have a field configurable name that corresponds to the name on the Oneline diagram. Programming software should not be required to change the load name.

4. The Load Control Screen shall show the status of each Load Level as follows:
a)Added
b)Shed
c)Restored

5. Generator Bus Metering Shall be displayed on the Load Control Screen.

6. Manual Add/Shed control of each load level shall be available.

L. Load Demand Screen

1. The Load Demand Screen Shall allow for enabling the Load Demand Function.

2. Functionality for Load Demand shall be field adjustable for the following engine shutdown sequences.

a)Operator Entered Sequence
b)Engine Run Hour Optimization Sequence
i. Rotate the Generator Shutdown Sequence automatically based on a field adjustable engine hour difference set point.
c)Engine Rotation Sequence
i. Rotate the shutdown sequence each time the generators are called to start.

3. The load demand function shall automatically adjust the load demand sequence to remove a generator that is shutdown on a fault, and to move a generator with an active warning to be the first generator to shut down in the sequence

4. The Load demand shutdown algorithm shall be field adjustable for the following methods:

a)Generator Operating Percentage
i. Adjusts the number of generators online based upon a shutdown and pickup loading percentage.

5. The following Load Demand set points shall be available for adjustment:

a)Initial Time Delay
b)Shutdown Time Delay
c)Restart Time Delay
d)Spare Capacity Pickup KW

6. A table shall be available to display the next generator to start, stop, and the respective kilowatt values for when each generator will start and stop based on the current Load Demand setup parameters.
a) Additionally the table shall show the availability of each generator in the system.

7. The Load Demand settings and sequence shall be verified by the control for accuracy and validity prior to implementing any changes.

M. Event Log Screen

1. The Event Log Screen shall log all events in the system. In general this should be any change in the system that does not require operator intervention or acknowledgement.

2. The Event Log shall log all state changes for Security Log, System Events, Breakers, Generators, and ATS as follows:

a)Generator
i. The generator has been given a start command
ii. The generator is warming up at idle
iii. The generator is running
iv. The generator is cooling down at rated speed
v. The generator is cooling down at idle
vi. The generator has stopped
b)Breaker
i. The circuit breaker is closed
ii. The circuit breaker is open
iii. The circuit breaker has been racked out (optional)
c)ATS
i. The ATS is connected to Normal
ii. The ATS is connected to Emergency
iii. The ATS is in the Neutral position
d)System
i. Changes in the system mode (Manual, Open Transition)
iii. Load Bus Selected
iv. Remote Commands Enable/Disable
v. Audible Alarm Silence
vi. Load Demand Mode
e)Security
i. User logon
ii. User log off
iii. User changed their password
iv. A user was added to the system
v. A user was removed from the system

3. The Event Log shall have the ability to filter events based on the event type or the date that an even occurred and be time stamped.

4. The Event log shall be able to show up to 1000 events.

5. The Event log shall be able to be printed.

6. The Event log shall be able to be cleared.

N. Current Alarm Screen

1. The Current Alarm Screen shall display all currently active or unacknowledged alarms

2. The alarm shall be time and date stamped.

3. The alarms shall be color coded by status of the alarm

a)Active Alarms should appear in Red
b)Active Alarms that have been acknowledged should appear in green
c)Inactive Alarms yet to be acknowledged should appear in blue

4. The current alarm list shall be able to be printed.

5. The current alarms shall be available to be emailed as they become active.

6. The DMC shall log at a minimum the following alarms:
a)Generator Alarms
i. Shutdown with Breaker Fail to Open
ii. Fail to Come Online
iii. Communication Failure
iv. Common Alarm
v. Not in Auto
vi. High Battery Voltage
vii. Low Battery Voltage
viii. Charger AC Failure
ix. Fail to Start
x. Low Coolant Temp
xi. PreHigh Engine Temp
xii. High Engine Temp
xiii. PreLow Oil Pressure
xiv. Low Oil Pressure
xv. Over speed
xvi. Low Coolant Level
xvii. Low Fuel Level
xviii. Generator Exhuast Gas Temperature
xix. High AC Voltage
xx. Low AC Voltage
xxi. Under Frequency
xxii. Overload
xxiii. Overcurrent
xxiv. Short Circuit
xxv. Reverse KW
xxvi. Reverse KVAR
xxvii. Fail to Sync
xxviii. Emergency Stop
xxix. NEC Fail to Open (optional)
xxx. NEC Fail to Close (optional)
b)Generator Breaker Alarms
i. In Manual
ii. Fail to Open
iii. Fail to Close
iv. Lockout Trip
v. Protective Relay Failure

vi. Unexpected Out of Cell
c)Main Circuit Breaker Alarms
i. Fail to Open
ii. Fail to Close
iii. Fail to Sync
iv. Aux Failure
v. Lockout Trip
vi. Protective Relay Failure
vii. Unexpected CB Open
viii. Unexpected CB Close
ix. Unexpected Change to Manual
x. Unexpected Out of Cell
xi. In Manual
d)Power Transfer Alarms
i. Transfer Pair Ramp Load Up Failure
ii. Transfer Pair Ramp Load Down Failure
iii. Transfer Pair Minimum Capacity Not Met)
iv. Transfer Pair Fail to Disconnect
e)Feeder Breaker Alarms
i. Fail To Open
ii. Fail To Close
iii. Lockout Trip
v. Protective Relay Fail
vi. In Manual
f)Load Control Alarms
i. Overload Alarm
ii. Load Shed Level (one alarm per shed level)
iii. Quick Shed
iv. Invalid Load Dump Signal
g)Communication Alarms
i. IO Link 1 Failure
ii. IO Link 2 Failure
iii. IO Device Warning
iv. IO Device Failure
v. IO Communication Alarm
vi. PLC to Touchscreen Communication Failure
h)System Alarms
i. Low Fuel Main Tank
ii. Remote Genset E-Stop Active
iii. System in Manual
iv. Master Synchronizer Hardware Failure
v. Station Power Best Battery Alarm
vi. Station Power From Batteries
vii. PLC Communication Failure
viii. PLC Memory Card Failure
ix. PLC Failure
x. HMI Low Disk Space
xi. Neutral Ground Resistor Fault (optional)
xii. NEC Failure (optional)

O. Alarm History Screen

1. The Alarm History database shall hold all recorded alarms for 365 days and shall be able to display up to 1000 alarms simultaneously.

2. The Alarm History Screen shall allow an operator to filter the displayed alarms by the following filter types

a)Date

b)Message (User entered text string)
c)Time

3. The displayed alarm history screen shall be able to be printed.

P. ATS Summary Screen (Optional)

1. The ATS Summary screen shall display ATS position for each networked ATS in the system.

2. The data displayed shall be at a minimum the following:

a)line to Line Voltage
b)Line to Neutral Voltage
c)Current
d)Frequency
e)Power Factor
f)Total kW
g)Total kVA
h)Total kVAR

3. The following annunciation points should be available:

a)Source 1 available
b)Source 1 connected
c)Source 2 available
d)Source 2 connected
e)Common Alarm
f)Not in Auto
g)Test / Exercise Mode
h)Load Shed
i)Transfer Inhibit
j)Retransfer Inhibit
k)Fail to Close
l)Fail to Disconnect
m)Bypass to Emergency
n)Bypass to Normal

4. A control option shall be available to allow for a remote test of each ATS in the system. The test function shall allow for a group of ATS to be selected and tested simultaneously.

Q. Scheduler Screen

1. The master control shall have the ability to run scheduled events based on a set Calendar and event type.

2. The Scheduler Screen shall allow for all setup and configuration of the Schedules including the following:

a)Repeat Intervals
i. Every Week
ii. Every 2 Weeks
iii. Every 4 Weeks
iv. First week of the month
v. Second week of the month
vi. Third week of the month
vii. Fourth week of the month
viii. Last week of the month

b)The day of the week for which the scheduled event will occur
c)The start time and duration of the event.
d)The mode of operation during the event
i. Test with load
ii. Test without load
iii. Extended Parallel
e)Up to 6 Schedule Exceptions
i. Exception day
ii. Exception repeat interval
iii. Start time and duration of exception

R. Reports

1. All Reports shall be available for view on the operator screen, saved to a USB media drive, printed, and viewed through the web server interface.

2. Generator Report
a)The generator report shall allow for a facility to record the necessary data to ensure compliance with NFPA 110.
b)The Generator report function shall allow for simultaneous reporting of all generators in the system.
c)Each generator shall be assigned a file with its respective reports.
d)The report shall allow for the following setup parameters
i. Minimum generator loading (adjustable from 0-100% of rated)
ii. Runtime
iii. Report Sample Rate (adjustable from 1 minute to 60 minutes)
e)The report shall record the following Generator parameters at a rate set by the Report Sample rate:
i. Oil Pressure
ii. Coolant Temp
iii. Battery Voltage
iv. Total kW
v. Percent kW
vi. Total KVAR
vii. Frequency
viii. Current Line (Phase)
ix. Voltage Line to Line (Phase)
f)The total time that the generator was above the minimum loading requirement shall be recorded.
g)The report shall have a field to enter operator comments.

3. Automatic Transfer Switch Report

a)The ATS report shall record any changes in switch position for each ATS in the system.
b)Upon the start of a new Calendar year, a new report shall be created for each ATS and the previous year's report shall be archived.
c)Each ATS in the system will have a separate report.

4. Run Report

a)The Run report shall record all events that occur during a system operation such as a utility outage or test.
b)The Report shall contain the following data and the time at which it occurred:
i. Utility Failure or Test Start Time
ii. Each generator command to start
iii. Each generator reaching rated frequency and voltage

iv. Each generator closing its circuit breaker
v. Transfer of ATS
vi. Operation of circuit breakers
vii. Each generator opening its circuit breaker
viii. Each generator has stopped

5. Operator Settings Report
a)The Operator Settings Report shall contain a list of all settings and parameters that can be changed by the operator.
b)The Operator Settings Report should include the following project information:
i. Project Name
ii. Model Number
iii. Order Number
iv. Serial Number
v. Distributor Contact Information

6. Factory Settings Report
a)The Factory Settings Report shall contain a list of all settings that are available in the factory (technician) setup screens.
b)These include at a minimum the following:
i. Project Information
ii. Generator Settings
iii. Meter Settings
iv. System Settings
v. Field adjustable device names
vi. Load types and Load Add Shed Setup

S. Security

1. The Security of the Operator Screen should have levels of security that allow different access for:

a)View only
b)Operators and Managers
c)Technicians
d)The Security should be setup so a user can be assigned to a level of access and have a unique log-in name and password.
e)The manager user level and above shall be allowed to add and remove unique users.
f)Each unique user's log in activity shall be recorded in the event log.
g)When multiple user interfaces are used (including the web interface) only one operator or above user shall be allowed to be logged in simultaneously for security purposes.
h)The security system should ensure that a strong password is used. The password rules should be a minimum of 8 characters and contain at least one alpha and one numeric.
i)The security system should have an auto logout period when there is no activity. This time delay should be field adjustable.

T. Integrity Checks

1. All operator and factory settings shall have integrity bounds checks built in to ensure that an only a valid entry is allowed.

U. Alarm and Report Notification

1. The building management interface shall be Modbus TCP/IP or

Modbus Serial EIA485.

2. When accessing the master control, the building management interface shall be restricted from direct access to the PLC so that there is no inadvertent security lapses.

V. Building Management Interface

1. The building management interface shall be Modbus TCP/IP or Modbus Serial EIA485.

2. When accessing the master control, the building management interface shall be restricted from direct access to the PLC so that there is no inadvertent security lapses.

X. Single Point of Control

1. The Operator Interface must have the provisions to ensure that only one operator is in control of the system at any access point to the master control. This includes all redundant, secondary, or web screen interfaces.

2. When the system has the control mode to "operator" the Scheduler shall not override the operator commands, but shall be paused until the Scheduler is again placed into control of the system.

Y. Help screens

1. Each screen in the system shall contain a detailed graphical help screen to allow an operator to understand the basic screen functions on each screen.

2. The help screens shall be available from the web interface screens.

Z. Time Synchronization

1. The operator interface real time clock shall be synchronized at all times to the PLC real time clock.

2. The master control real time clock shall have the capability of synchronizing with a NTP time server.

AA. Printing

1. The Operator Interface shall be capable of connecting to either a local to allow printing of alarms, events, reports, trends, etc.

2.2.6 Internal Controls

Internal Controls for the Master control should be comprised of the following:

A. Expected Monitoring I/O

A. Expected Monitoring I/O
1. The Master Control shall monitor the following breaker status at a minimum.

a)Aux A contact.
b)Aux B contact (optional)
c)Cell position (if applicable)
d)Tripped Status
e)Auto or Manual control mode status
f)Protective Relay Failure (if applicable)

2. The Master Control shall monitor the following generator status points through hard wired inputs at a minimum.

a)Ready to Load (90% rated voltage and frequency)
b)Shutdown
c)Load Dump/Load Shed

B. The Master Control shall use circuit protection for control circuitry that indicates when the protective device needs to be reset or replaced.

C. The Master Control shall allow for all field wiring to be landed on dedicated terminal blocks. The terminal blocks shall be rated to be capable of the largest required wire gauge that may be required for field wiring.

D. All Control Relays in the Master Control shall have LED indicators.

E. The Master Control 125VDC bus for control power shall be derived from a "best battery". The "best battery" shall combine the 125VDC battery supplies from each station battery power supply. Provisions must be available for the station battery system: 125VDC source via sealed lead acid batteries, to be added to the best battery bus. Battery bank, rack, and charger to be provided with switchgear as shown on sheet EP101.

F. The station battery included with the Master Control shall be capable of supplying the entire cabinet's power requirements during starter dip of the engine generators, as well as be able to fully supply the power requirements in the case of a failure of all generator batteries. The station battery system shall consist of a 125VDC power supply and a 125 VDC battery bank capable of supplying the Master Control power indefinitely during normal conditions, all protective relaying equipment as specified in section 2.3.3, and all accessories located in Switchgear USA, USB, GSA, GSB, and motorized breakers in Switchboards DHA & DHB, and for at least 30 minutes during an entire facility outage before additional charging is required.

G. When paralleling with the Utility, a Master Synchronizer and kW/KVar controller shall be used to ensure the generators are synchronized with the Utility prior to paralleling. The master synchronizer shall be designed and manufactured by the generator control and master control manufacturer to ensure compatibility and optimized algorithms for synchronizing.

H. The Master Control shall be able to actively control kW and kVAR output of the generator in multiple modes:

1. Closed Loop PI Control to control Utility kW and KVAR import.

a)Closed Loop PI Control to control Generator kW and kVAR outputs, with an option to constrain the utility export/import value.

b)Open Loop control to hold the Generator % kW and kVAR outputs constant.
c)Closed Loop PI control to hold the Generator power factor constant.
d)Closed Loop PI control to hold the Utility power factor constant.

2. The controller shall calculate the amount of power to be produced by the generators at a minimum of 50 times per second.

I. Sequence Of Operation

Refer to attached for Sequence of Operations for Paralleling System:

26 13 13 Attachment 2 - Generator Controls Sequence of Operations

2.3 METAL-CLAD SWITCHGEAR

IEEE C37.20.2A.

2.3.1 Ratings

Provide equipment with the following ratings:

a. Voltage rating: 15.0 kilo-volts AC, three-phase, high resistance grounded . For high resistance grounded systems, the conductors from the neutral point to the connection point at the impedance must utilize copper conductors, employing the same insulation level and construction as the phase conductors.

b. Short Circuit Rating: 25 kA.

c. UL listed and labeled for its intended use.

d. Impulse Withstand (Basic Impulse Level): 95 KV.

e. Power Frequency Withstand: 36 KV, 1 minute test.

f. Momentary Current Ratings must be equal to the circuit breaker close and latch rating.

g. System voltage: 15 KV nominal, three-phase ungrounded, 60 hertz .

h. Continuous current rating of the main bus: 1200 amperes.

2.3.2 Construction

Provide the following:

a. Dead-front, metal-clad, draw-out, switchgear assembly of vertical sections, each with vacuum circuit breakers. Switchgear must be front and rear accessible. Provide front and rear vertical section covers with full length hinges. Provide additional vertical sections to house accessories related to the switchgear functions.

b. Switchgear: Vertical sections bolted together to form a rigid assembly and front and rear aligned.

c. All circuit breakers: Front accessible with rear load connections.

d. Compartmentalized switchgear: Vertical insulating barriers between

the front device section, the main bus section, and the cable compartment with full front to rear vertical insulating barriers between adjacent sections.

e. Where indicated, "space for future" or "space" means to include all necessary components and hardware to be fully equipped for racking in a circuit breaker element.

f. Insulating barriers: Provided in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness.

h. Switchgear: Arc-resistant Type 2B , tested in accordance with IEEE C37.20.7.

2.3.2.1 Enclosure

Provide the following:

a. Stationary Structure:

(1) The switchgear must consist of sections including circuit breaker compartments and auxiliary compartments assembled to form a rigid self-supporting completely enclosed structure providing steel barriers between sections.

(2) The sections must be divided by metal barriers into the following separate compartments: Circuit breaker, instrument, main bus, auxiliary device and cable. Each feeder section may have up to two circuit breaker compartments.

b. Indoor Enclosure: NEMA ICS 6 Type 1.

d. Enclosure: Bolted together with removable bolt-on side and hinged rear covers, and sloping roof downward toward rear.

e. Front and rear doors: Provided with pad-lockable vault handles with a three point catch.

f. Bases, frames and channels of enclosure: Corrosion resistant and fabricated of galvanized steel.

g. Base: Includes any part of enclosure that is within 3 inches of concrete pad.

h. Galvanized steel: ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

i. Paint color: Factory applied finish, ASTM D1535 light gray No. 61 or No. 49 over rust inhibiting primer on treated metal.

j. Paint coating system: Comply with IEEE C57.12.28 for galvanized steel.

k. Infrared viewing windows: Install to allow the use of an infrared camera or thermal imager direct line of site to inspect electrical connections without requiring the opening of panels and doors. These windows are intended to allow thermographers the ability to inspect the electrical equipment without directly exposing themselves to live electrical components and energized devices.

i. Mimic Bus: Each switchgear section to be provided with a Mimic Bus.

2.3.2.2 Bus Bars

Provide the following:

a. Bus bars: Copper with silver-plated contact surfaces.

(1) Phase bus bars: Insulated with an epoxy finish coating powder or insulating sleeve providing a minimum breakdown voltage per ASTM D149.

b. Make bus connections and joints with hardened steel bolts and nuts. Provide conical disk spring washers under each nut and bolt.

c. Main-bus (through bus): Rated at the full ampacity of the main throughout the switchgear.

d. Minimum 1/4 by 2 inch copper ground bus secured to each vertical section along the entire length of the switchgear.

2.3.2.3 Circuit Breaker Compartments

a. Each circuit breaker must be draw-out metal-clad vacuum circuit breaker. The stationary primary disconnecting contacts must be silver-plated copper and mounted within porcelain support bushings. The movable contacts and springs must be mounted on the circuit breaker element for ease of inspection/maintenance.

b. Entrance to the stationary primary disconnecting contacts must be automatically covered by metal shutters when the circuit breaker is withdrawn from the connected position to the test or disconnected position or removed from the circuit breaker compartment. Ground bus must be extended into the circuit breaker compartment to automatically ground the breaker frame with high-current spring type grounding contacts located on the breaker chassis when in the test and connected positions. Guide rails for positioning the circuit breaker and all other necessary hardware must be an integral part of the circuit breaker compartment. Blocking devices must interlock breaker frame sizes to prevent installation of a lower ampere rating or interrupting capacity element into a compartment designed for one of a higher rating.

2.3.2.4 Auxiliary Vertical Sections and Compartments

a. Provide auxiliary sections consisting of instruments, metering equipment, control equipment, transformers, and current transformer compartments as indicated.

d. Metering: Hinged panel in switch or breaker section, for isolated access to meters and associated terminal and fuse blocks for maintenance, calibration, or testing while the gear is energized.

2.3.2.5 Medium Voltage Cable Terminations

a. IEEE 48 Class 1; of the molded elastomer, pre-stretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such

as ethylene propylene rubber or ethylene propylene diene monomer. Terminations, where required, must be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Terminations must be provided in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

b. Cold-Shrink Type: Terminator must be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination must not require heat or flame for installation. Termination kit must contain all necessary materials (except for the lugs). Termination must be designed for installation in low or highly contaminated indoor and outdoor locations and must resist ultraviolet rays and oxidative decomposition.

c. Heat Shrinkable Type: Terminator must consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is non-tracking, resists heavy atmospheric contaminants, ultra-violet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Termination must be designed for installation in low or highly contaminated indoor or outdoor locations.

2.3.2.6 Circuit Breakers

The vacuum circuit breakers must be electrically-operated, three-pole, circuit interrupting devices rated for 1200 amperes continuous at 15 kV and 95 kV BIL. Breakers must be designed for service on a 15 kV system with a short-circuit capacity of not less than 12.5 kA rms Sym. Rating must be based on IEEE C37.04 and IEEE C37.06. Circuit breakers must be draw-out mounted with position indicator, operation counter, auxiliary switches, and primary and secondary disconnect devices. Circuit breakers must have one vacuum circuit interrupter per phase.

Circuit breaker must be operated by an electrically charged, mechanically and electrically trip-free, stored-energy operating mechanism normally charged by a universal motor. Provide for manual charging of the mechanism through a manual handle on the vacuum circuit breaker. Circuit breaker control voltage must be 125 VDC 120 VAC. Provide one capacitor trip unit for each breaker when AC control power is required.

a. Contacts: Silver-plated, multi-finger, positive pressure, self-aligning type for main draw-out contacts.

b. Each draw-out breaker must be provided with three-position operation. The connected position and the test/disconnect position must be clearly identified by an indicator on the circuit breaker front panel.

(1) Connected position: Contacts are fully engaged. Breaker must be tripped before it can be racked into or out of this position.

(2) Test/disconnect position: Position must allow for complete testing and operation of the breaker without energizing the

primary circuit.

(3) Withdrawn (removed) positions: Places breaker completely out of compartment, ready for removal.

c. Secondary control circuits must be connected automatically with a self-aligning, self-engaging plug and receptacle arrangement when the circuit breaker is racked into the connected position.

d. An interlocking system must be provided to prevent racking a closed circuit breaker to or from any position. An additional interlock must automatically discharge the stored-energy operating mechanism springs upon removal of the breaker out of the compartment.

e. Provision for secondary control plug to be manually connected in test position.

f. A minimum of 4 auxiliary contacts (2a 2b) for external use.

2.3.2.7 Circuit Breaker Remote Racking

Provide a remote racking mechanism to allow an operator to rack a circuit breaker in or out from at least 20 feet away from the front of the equipment.

2.3.3 Protective Relays

Relays must conform to IEEE C37.90. Protective relays must be solid-state microprocessor based, multi-function type enclosed in rectangular, semi flush, switchgear-type draw-out cases with indicating targets and provisions for testing in place by use of manufacturer's standard test blocks or test switches. One complete set of test blocks or test switches to fit each type of relay in the equipment must be provided. Auxiliary and lockout relays are not required to have draw-out cases or test provisions. Controls, relays, and protective functions must be provided completely assembled and wired.

a. Protective relay types, refer to sheet EP600 series sheets:

(1) UM, GM, and T breakers are to be a electronic feeder protection relay with a 5" touch screen. All sensorss are to be point sensors. Relay is to protect radial and looped circuits with various protection capabilities including overcurrent, directional overcurrent, autoreclosing, over/undervoltage, frequency, synchronosation, etc. Relay to be provided with arc-flash detection with arc sensing technology to detect arcing produced by high impedance faults and will send an alarm or trip the breaker. Communications to be accomplised by copper or fiber optic ethernet ports, etc.

(2) F breakers are to be a electronic feeder protection with a 5" touch screen. and arc fault sensing. All sensorss are to be point sensors. All sensorss are to be point sensors. Relay is to protect radial and looped circuits with various protection capabilities including overcurrent, directional overcurrent, autoreclosing, over/undervoltage, frequency, synchronosation, etc. Relay to be provided with arc-flash detection with arc sensing technology to detect arcing produced by high impedance faults and will send an alarm or trip the breaker. Communications

to be accomplised by copper or fiber optic ethernet ports, etc.

(3) G breakers are to be a electronic generator protection relay with a 5" touch screen. All sensorss are to be point sensors. Relay is to provide backup generator protection with current, frequency, power, out-of-step, ground, synchrononosation, etc. Relay to be provided with arc-flash detection with arc sensing technology to detect arcing produced by high impedance faults and will send an alarm or trip the breaker. Communications to be accomplised by copper or fiber optic ethernet ports, etc.

(4) Electronic bus differintial relay with a 5" touch screen. All sensorss are to be point sensors. Relay is to provide protection bus differenctial protection for overcurrents and breaker failure overcurrentst. Relay to be provided with arc-flash detection with arc sensing technology to detect arcing produced by high impedance faults and will send an alarm or trip the breaker. Communications to be accomplised by copper or fiber optic ethernet ports, etc.

(5) Electronic module for time synchronization for up to 12 demodulated IRIG-B outputs to provide sime sensitive information.

Contractor shall be responsible for providing all conduit, cable, metering, and other ancillary devices required for a complete and functional protective relay system.

2.3.3.1 Instruments

ANSI C39.1 for electrical indicating switchgear instruments, with one percent accuracy class, antiparallax pointer, and glare-free face with scales as indicated and coordinated to the ratios of the current and potential transformers provided. AC ammeters and voltmeters must be a minimum of 2 inches square, with 4.36 rad 250 degree scale. Provide single-phase indicating instruments with flush-mounted transfer switches for reading three phases.

a. AC ammeters: Transformer rated, 5-ampere input, 60 Hz.

b. AC voltmeters: Transformer rated, 150-volt input, 60 Hz.

c. AC wattmeters: Transformer rated for 120-volt input, 60 Hz, three-phase, four-wire, with scale range coordinated to the ratios of the associated current transformers and potential transformers.

d. Frequency meters: Rated for 120-volt input, 60 Hz nominal frequency, 40 to 80 Hz scale range.

2.3.3.2 Instrument Control Switches

Provide rotary cam-operated type with positive means of indicating contact positions. Switches must have silver-to-silver contacts enclosed in a protective cover which can be removed to inspect the contacts.

2.3.3.3 Electronic Watthour Meter

ANSI C12.1. Provide a switchgear style electronic programmable watthour meter, semi-flush mounted, as indicated. Meter can be either programmed at the factory or programmed in the field. Turn field programming device over to the Contracting Officer at completion of project. Coordinate

meter to system requirements.

a. Design: Provide meter designed for use on a 3-phase, 3-wire volt system with 3 current transformers. Include necessary KYZ pulse initiation hardware for Energy Monitoring and Control System (EMCS).

b. Coordination: Provide meter coordinated with ratios of current transformers and transformer secondary voltage.

c. Class: 20. Accuracy: plus or minus 1.0 percent. Finish: Class II.

d. Kilowatt-hour Register: five digit electronic programmable type.

e. Demand Register:

(1) Provide solid state.

(2) Display actual values and readings of the metered circuit. No multipliers must be required.

(3) Demand interval length: programmed for 15 minutes with rolling demand up to six subintervals per interval.

f. Meter fusing: Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to the watthour meter. Size fuses as recommended by the meter manufacturer.

g. Provide meter with a communications port, RS485, wCAT 6.

IEEE C57.13.

Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

2.3.4 Instrument Transformers

IEEE C57.13, as applicable.

a. Current transformers: Each breaker compartment must have provision for front-accessible mounting of up to four current transformers per phase (ANSI standard relay accuracy), two on bus side and two on cable side of circuit breaker. The current transformer assembly must be insulated for the full voltage rating of the switchgear. The current transformers wiring must be Type SIS No. 10 AWG copper.

b. Potential transformers: Transformers must be drawout type, 60 Hz, with voltage ratings and ratios coordinated to the ratings of the associated switchgear, relays, meters, and instruments. Potential transformers must be with one fuse in the primary. Fuses must be current limiting and sized as recommended by the potential transformer manufacturer.

2.3.5 Pilot and Indicating Lights

Provide LED type pilot and indicating lights, color as indicated on the drawings.

2.3.6 Metering

2.3.6.1 Digital Metering

All meters shown on EP600 series sheet compliant with the AMRS Meter Specifications attached.

IEEE C37.90.1 for surge withstand. Provide true rms, plus/minus one percent accuracy, programmable, microprocessor-based meter enclosed in a sealed case with the following features.

a. Display capability:

(1) Multi-Function Meter: Display a selected phase to neutral voltage, phase to phase voltage, percent phase to neutral voltage THD, percent phase to phase voltage THD; a selected phase current, neutral current, percent phase current THD, percent neutral current; selected total PF, kW, KVA, kVAR, FREQ, kVAh, kWh. Detected alarm conditions include over/under current, over/under voltage, over/under KVA, over/under frequency, over/under selected PF/kVAR, voltage phase reversal, voltage imbalance, reverse power, over percent THD. Include a Form C KYZ pulse output relay on the meter. Provide connection/interface to water meter for usage and total consumption trending. All information to report to the respected DMCP for recording and download.

b. Design meters to accept input from standard 5A secondary instrument transformers.

c. Provide programming via a front panel display and a communication interface accessible by a computer.

d. Provide password secured programming stored in non-volatile EEPROM memory.

e. Provide digital communications via CAT 6 cable..

f. Provide meter that calculates and stores average max/min demand values with time and date for all readings based on a user selectable sliding window averaging period.

g. Provide meter with programmable hi/low set limits with two Form C dry contact relays when exceeding alarm conditions.

h. Provide meter with a display of Total Harmonic Distortion (THD) measurement to a minimum of the thirty-first order.

i. Include historical trend logging capability with the ability to store up to 100,000 data points with intervals of 1 second to 180 minutes. Provide a unit that can store and time stamp up to 1000 programmable triggered conditions.

j. Provide event waveform recording triggered by the rms of 2 cycles of voltage or current exceeding programmable set points. Store waveforms for all 6 channels of voltage and current for a minimum of 10 cycles prior to the event and 50 cycles past the event.

2.3.7 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Provide short-circuiting type terminal boards associated with current transformer. Terminate conductors for current transformers with ring-tongue lugs. Identify each terminal to indicate the load served.

2.3.8 Wire Marking

Mark control and metering conductors at each end. Provide factory installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Provide a single letter or number on each sleeve, elliptically shaped to securely grip the wire, and keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Indicate on each wire marker the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.3.9 Surge Arresters

Provide one surge arrester for each conductor on circuits where indicated. Surge arresters must conform to IEEE C62.11 for station class and must be rated 15 kV.

2.3.10 Control Wiring

The switchgear control wiring must be type SIS No. 14 AWG copper minimum, except where larger size wire is required.

2.4 MANUFACTURER'S NAMEPLATE

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.5 FIELD FABRICATED NAMEPLATES

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 0.125 inch thick, white with black center core.

e. Provide red laminated plastic label with white center core where indicated.

f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

g. Minimum size of nameplates: one by 2.5 inches.

h. Lettering size and style: a minimum of 0.25 inch high normal block style.

2.6 SOURCE QUALITY CONTROL

2.6.1 Equipment Test Schedule

The Government reserves the right to witness tests and must sign off on all test(s) performed. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Perform production tests on each circuit breaker housing for this Project, complying with IEEE C37.09.

(1) Perform mechanical operation tests to ensure proper functioning of shutters, operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.

(2) Conduct an alignment test with master circuit breaker to verify all interfaces.

(3) Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.

(4) Perform the control wiring dielectric test at 1500 V for one minute.

(5) Perform the dielectric test on primary and secondary circuits.

b. Perform production tests, on each circuit breaker supplied for this Project, complying with IEEE C37.09.

(1) Perform mechanical operation tests to ensure proper functioning of the switch.

(2) Conduct an alignment test with master cell to verify all interfaces and interchangeability.

(3) Verify the contact gap. Perform terminal-to-terminal resistance test.

(4) Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence. Operate the circuit breakers over the range of minimum to maximum of the control voltage.

(5) Perform the control wiring dielectric test at 1500 V for one

minute.

(6) Set the contact gap.

2.6.2 Cybersecurity Equipment Certification

Furnish a certification that control systems are designed and tested in accordance with DOD 8500.01, DOD 8510.01, and as required by the related Section 25 05 11 variant.

2.6.3 Switchgear Design Tests

IEEE C37.20.2A or IEEE C37.20.3 as applicable. Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification. Required tests shall be as follows:

a. Design Tests

1. Dielectric test

2. Rated continuous current test

3. Short-circuit current withstand tests

4. Mechanical endurance tests

5. Flame-resistance tests

6. Rod entry tests

2.7 COORDINATED POWER SYSTEM STUDY

Provide a power system study as specified in Section 26 05 73 POWER SYSTEM STUDIES.

2.8 ARC FLASH WARNING LABEL

Provide warning Arc Flash Hazard Warning Labels labels in accordance with the Power System Study Section 26 05 73 label for switchgear. Locate this self-adhesive warning label on the outside of the enclosure warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

2.9 SERVICE ENTRANCE AVAILABLE FAULT CURRENT LABEL

Provide label on exterior of switchgear used as service equipment listing the maximum available fault current at that location. Include on the label the date that the fault calculation was performed and the contact information for the organization that completed the calculation. Locate this self-adhesive warning label on the outside of the switchgear. At the contractor's discretion, the service entrance available fault current label may be incorporated into the Arc Flash Label required by 26 05 73 POWER SYSTEM STUDIES.

2.10 MIMIC BUS LABELING

Provide a mimic bus on the front of the equipment to diagrammatically show the internal bus structure of the lineup.

PART 3 EXECUTION

3.1 EXAMINATION

A. The installer shall be responsible for inspection of the site and verification that the equipment can be installed and operated as required by the manufacturer.

3.2 FACTORY TESTING

a. Perform and report on factory testing and inspections prior to shipment of switchgear. Provide certified copies of manufacturer's test data and results. Test procedures to conform to ASME, IEEE, IEC, and ANSI standard, and to ISO requirements on testing, as appropritately applicable. The manufacturer performing the tests must provide equipment, labor, and consumables necessary for tests and measuring and indicating devices must be certified to within calibration. Prior to shipment of the equipment to the jobsite, the entire control system (including generator set controls) and all the new switchgear directly controlled by the control system shall be tested together at the manufacturer's facility to demonstrate that it is fully functional prior to shipment to the jobsite. No exceptions to the requirements of this paragraph will be accepted.

   All factory testing will be observed by the Engineer of Record or the Engineer of Record's designee. Submit a letter giving notice of the proposed dates of factory inspections and tests at least 60 days prior to beginning tests in order to schedule observing such testing. The factory test procedures shall be provided simultaneous or prior to the aforementioned notice.

b. The system shall be static tested to a level that exceeds the agreed upon Generator Controls Sequence of Operations (Refer to 3.11.2.1.A for further details) including but not limited to:

   1. All combinations of Generator 1, 2, 3 or 4 Failure.

   2. Network Communications Failures.

   3. Control System Component Failures.

   4. Unexpected Breaker Operation (trips, component failures, etc).

   5. Generator Controls Sequence of Operations.

   6. Breaker Failure Modes (Fail to Close, Fail to Open).

c. Each Failure Mode Test shall be documented and included in the O&M Manual.

3.3 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

A. The equipment shall be installed as recommended by the equipment

manufacturer.

B. Remove temporary lifting provisions prior to commissioning.

3.4 IDENTIFICATION

A. Mount permanent operating instructions at each transfer point, and at the system master control. Instructions shall include a one-line system drawing, description of the operating sequences of the system and the manual operation instructions for the panel where they are installed.

B. A notice indicating location of the operation and maintenance manual shall be provided.

C. A notice indicating service support information including supplier name, telephone numbers, and manufacturer's contact information shall be provided on each major piece of equipment.

3.5 CONNECTIONS

A. Ground each piece of equipment according to the requirements elsewhere in Division 26 "Grounding and Bonding for Electrical Systems", and in compliance with instructions in the drawings.

B. Connect power conductors in compliance to appropriate instructions based on voltage class, elsewhere in Division 26.

C. Provide control interconnection wiring and connect all control interconnections in strict compliance to the equipment manufacturers' instructions.

3.6 ADJUSTING

A. Set all protective relaying according to the results as required by a coordination study. Set all other settings as recommended by the equipment manufacturer.

B. Record all settings and provide in system operation and maintenance manuals.

3.7 CLEANING

A. All equipment is to be thoroughly cleaned, with any shipping or installation damage repaired, prior to equipment commissioning and final test.

3.8 PROTECTION

A. Equipment shall be protected from the environment in compliance to manufacturer's recommendations. As a minimum, equipment shall be protected from moisture, dirt, and condensation.

3.9 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.9.1 Medium-Voltage Switchgear

IEEE C37.20.2A and IEEE C37.20.3 as applicable.

3.9.2 Meters and Instrument

Transformers ANSI C12.1.

3.9.3 Galvanizing Repair

Repair damage to galvanized coatings caused by handling, transporting, cutting, welding, or bolting. Make repairs in accordance with ASTM A780/A780M, zinc rich paint. Do not heat surfaces that repair paint has been applied to.

3.10 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.10.1 Interior Location

Mount switchgear on concrete slab. Unless Otherwise indicated, the slab must be at least 4 inches thick. Top of concrete slab must be approximately 4 inches above finished floor. Edges above floor must have 1/2 inch chamfer. Slab must be of adequate size to project at least 8 inches beyond the equipment, except that front of slab must be large enough to serve as a platform to withdraw breakers or to operate two-high breaker lifters. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.11 FIELD QUALITY CONTROL

Submit Request for Settings of breakers to the Contracting Officer after approval of switchgear and at least 30 days in advance of their requirement.

A. Prior to acceptance testing, test insulation resistance of each switchgear bus, component, connecting supply, feeder, and control circuit (in compliance and under supervision of equipment manufacturer(s).) Test continuity of each circuit. Retain permanent records of this testing.

B. A factory-authorized and certified service technician shall inspect all control wiring for type of wiring material and installation practice, verify that the wiring is properly installed by point to point testing, and complete installation and startup checks as required by the equipment manufacturer.

3.11.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.11.1.1 Medium-Voltage Vacuum Circuit Breakers

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Inspect anchorage, alignment, and grounding.

(5) Perform all mechanical operational tests on both the circuit breaker and its operating mechanism.

(6) Measure critical distances such as contact gap as recommended by manufacturer.

(7) Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey is required.

(8) Record as-found and as-left operation counter readings.

b. Electrical Tests

(1) Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data, in the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values must be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests must not proceed until insulation-resistance levels are raised above minimum values.

(2) Perform a contact/pole-resistance test. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value. Microhm or dc millivolt drop values must not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

(3) Perform minimum pickup voltage tests on trip and close coils according to manufacturer's published data. Minimum pickup voltage of the trip and close coils must comply with manufacturer's published data. In the absence of the manufacturer's published data, comply with NETA ATS, Table 100.20.

(4) Verify correct operation of any auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features must operate according to manufacturer's published data.

(5) Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.

(6) Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed. Power-factor or dissipation-factor values must comply with manufacturer's published data.

(7) Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with the contacts in the "open" position according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the vacuum bottle integrity test, the test specimen is considered to have passed the test.

(8) Perform a dielectric-withstand-voltage test according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

Verify operation of heaters.

3.11.1.2 Switchgear Assemblies

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical, electrical, and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Verify appropriate anchorage, required area clearances, and correct alignment.

(5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

(6) Verify that circuit breaker sizes and types correspond to approved shop drawings.

(7) Verify that current and potential transformer ratios correspond to approved shop drawings.

(8) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey is required.

(9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

(10) Clean switchgear.

(11) Inspect insulators for evidence of physical damage or contaminated surfaces.

(12) Verify correct barrier and shutter installation and operation.

(13) Exercise all active components.

(14) Inspect all mechanical indicating devices for correct operation.

(15) Verify that vents are clear.

(16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

(17) Inspect control power transformers.

b. Electrical Tests

(1) Perform insulation-resistance tests on each bus section.

(2) Perform overpotential tests.

(3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

(4) Perform control wiring performance test.

(5) Perform primary current injection tests on the entire current circuit in each section of assembly.

(6) Perform phasing check on double-ended switchgear to ensure correct bus phasing from each source.

(7) Verify operation of heaters.

3.11.1.3 Instrument Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey is required.

(6) Verify that all required grounding and shorting connections provide good contact.

(7) Verify correct operation of transformer with drawout mechanism and grounding operation.

(8) Verify correct primary and secondary fuse sizes for potential transformers.

b. Electrical Tests - Current Transformers

(1) Perform insulation-resistance tests.

(2) Perform polarity tests.

(3) Perform ratio-verification tests.

(4) Perform excitation test on transformers used for relaying applications.

(5) Measure circuit burden at transformer terminals and determine the total burden.

(6) When applicable, perform insulation resistance and dielectric withstand tests on the primary winding with secondary grounded.

(7) CAUTION: Changes of connection, insertion, and removal of instruments, relays, and meters must be performed in such a manner that the secondary circuits of energized current transformers are not opened momentarily.

c. Electrical Tests - Voltage (Potential) Transformers

(1) Perform insulation-resistance tests.

(2) Perform a polarity test on each transformer to verify the polarity marks or H1 - X1 relationships as applicable

(3) Perform a turns ratio test on all tap positions, if applicable.

(4) Measure potential circuit burdens at transformer terminals and determine the total burden.

(5) Measure circuit burden at transformer terminals and determine the total burden.

3.11.1.4 Battery Systems

a. Visual and mechanical inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey is required.

(4) Measure electrolyte specific gravity and temperature and visually check fill level.

(5) Verify adequacy of battery support racks, mounting, anchorage, and clearances.

b. Electrical tests

(1) Set charger float and equalizing voltage levels.

(2) Verify all charger functions and alarms.

(3) Measure each cell voltage and total battery voltage with charger

energized and in float mode of operation.

(4) Perform a capacity load test.

3.11.1.5 Metering and Instrumentation

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests

(1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

(2) Calibrate watthour meters according to manufacturer's published data.

(3) Verify all instrument multipliers.

(4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.11.1.6 Protective Relays

Protective relays must be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests must include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings must be implemented in accordance with the settings in accordance with the approved overcurrent protective device coordination study. Relay contacts must be manually or electrically operated to verify that the proper breakers and alarms initiate.

3.11.1.7 Cybersecurity Installation Certification

Furnish a certification that control systems are installed in accordance with DOD 8500.01, DOD 8510.01, and as required by the related Section 25 05 11 variant.

3.11.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor must show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers must be tripped by operation of each protective device. Test must require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 10 working days in advance of the dates and times for checks, settings, and tests.

3.11.2.1 On-site Functional Performance Testing

A. Upon completion of the above verification and testing a Functional

Performance Test shall be performed to a level that exceeds the agreed upon Generator Controls Sequence of Operations including but not limited to:

1. All combinations of Generator 1, 2, 3 or 4 Failure.

2. Network Communications Failures.

3. Control System Component Failures.

4. Unexpected Breaker Operation (trips, component failures, etc).

5. Generator Controls Sequence of Operations.

6. Breaker Failure Modes (Fail to Close, Fail to Open).

B. Each Failure Mode Test shall be documented and included in the O&M Manual.

3.11.2.2 Training

The supplier of the paralleling system shall provide a manufacturer-certified representative to train the owner's personnel in the proper operation and maintenance of the paralleling system.

The training period must consist of a mimum 4 hours of normal working time and must start after the system is functionally completed but prior to final acceptance and must be video tapped.

-- End of Section --

GENERAL NOTES

1. PERFORM WORK IN ACCORDANCE WITH THE FOLLOWING CODES AND STANDARDS:
   -NATIONAL ELECTRICAL CODE 2017 WITH LOCAL AMENDMENTS (NFPA 70)
   -INTERNATIONAL BUILDING CODE 2015 (IBC)
   -INTERNATIONAL ENERGY CONSERVATION CODE 2015 (IECC)
   -THE LIFE SAFETY CODE 2015 (NFPA 101)
2. FIELD VERIFY DIMENSIONS AND ELEVATIONS IN THE AREA OF WORK PRIOR TO THE START OF WORK.
3. MODIFICATIONS TO THESE DOCUMENTS DUE TO UNFORESEEN FIELD CONDITIONS MUST BE APPROVED BY THE ENGINEER OF RECORD AND INDICATED ON THE AS-BUILT DRAWINGS.
4. PROVIDE NEW EQUIPMENT LISTED AND LABELED FOR ITS INTENDED USE UNLESS INSTRUCTED OTHERWISE.
5. SEAL PENETRATIONS OF FIRE RATED CONSTRUCTION WITH U.L. APPROVED FIRE STOPPING MATERIAL TO RESTORE THE ORIGINAL FIRE RESISTANCE RATING OF THE PENETRATED CONSTRUCTION.
6. WHERE PROVIDED, EQUIPMENT MODEL NUMBERS INDICATE THE BASIS OF DESIGN EQUIPMENT. PRODUCTS FROM LISTED APPROVED EQUAL MANUFACTURERS ARE ACCEPTABLE.
7. THESE DOCUMENTS CALL FOR FINISHED WORK, TESTED AND READY FOR OPERATION. THE TERM "PROVIDE" MEANS "FURNISHED AND INSTALLED COMPLETE AND READY FOR USE." COORDINATE EXACT LOCATIONS OF DEVICES WITH EQUIPMENT VENDORS PRIOR TO INSTALLATION.
8. PROVIDE EQUIPMENT GROUNDING CONDUCTOR FOR EACH CIRCUIT.
9. PROVIDE NYLON PULL STRING IN EMPTY CONDUITS.
10. LABEL JUNCTION BOXES WITH PANEL DESIGNATION AND CIRCUIT NUMBER.
11. PRIOR TO FINAL ACCEPTANCE; CLEAN DEVICES, DEVICE PLATES, CABINETS, LUMINARIES, AND OTHER EQUIPMENT PROVIDED UNDER THIS CONTRACT; ENSURE THAT PANEL DIRECTORIES ARE REVISED AND/OR COMPLETED AND IN PLACE; AND THAT MARKING AND IDENTIFICATION OF COMPONENT IS COMPLETE.
12. REPAIR OR REPLACE, AND AT NO ADDITIONAL COST, ITEMS DAMAGED DURING THE COURSE OF THE WORK IF CAUSED BY CONTRACTOR.
13. REPLACE AND RETEST DEFECTIVE WIRING, DEVICES, AND EQUIPMENT THAT IS ENCOUNTERED DURING THE COURSE OF TESTING.
14. MOUNTING HEIGHTS ARE MEASURED FROM FINISHED FLOOR TO CENTER OF DEVICE UNLESS NOTED OTHERWISE.
15. MAKE FINAL CONNECTIONS TO DEVICES AND EQUIPMENT FURNISHED BY OTHER TRADES.
16. ABBREVIATIONS ARE SHOWN FOR REFERENCE ONLY AND MAY NOT BE USED IN DRAWING PACKAGE.
17. SYMBOLS ARE SHOWN FOR REFERENCE ONLY AND MAY NOT BE USED IN DRAWING PACKAGE.
18. IN ACCORDANCE WITH NEC 300.7, PROVIDE REQUIRED SEALING WHERE PORTIONS OF A RACEWAY OR SLEEVE ARE KNOWN TO BE SUBJECTED TO DIFFERENT TEMPERATURES. WHERE PASSING FROM THE INTERIOR TO THE EXTERIOR OF A BUILDING, THE RACEWAY OR SLEEVE SHALL BE FILLED WITH AN APPROVED MATERIAL TO PREVENT THE CIRCULATION OF WARM AIR TO A COLDER SECTION OF THE RACEWAY OR SLEEVE.
19. ALL CONDUCTORS, RACEWAYS AND CABLES SHALL BE CONCEALED IN CEILING OR WALLS IN FINISHED SPACES.
20. ALL RACEWAYS RUNNING THROUGH BUILDING EXPANSION JOINTS SHALL BE EQUIPPED WITH EXPANSION FITTINGS.
21. IF DAMAGES AND/OR ISSUES FROM PREVIOUS INSTALLATIONS ARE FOUND DURING THE REPLACEMENT, CONTACT GOVERNMENT POC FOR APPROVAL TO REPAIR OR REPLACE.
22. ALL WORK SHALL BE ACCOMPLISHED IN SUCH A MANNER AS TO KEEP FACILITY SYSTEMS OPERATIONAL 100% OF THE TIME. THE FACILITY IS BASED ON REDUNDANT SOURCES OF POWER (2N). SEQUENCE THE WORK SO THAT THE EXISTING SYSTEMS REMAIN OPERATIONAL WHILE THE NEW SYSTEMS ARE INSTALLED AND OPERATIONAL, MAINTAINING A MINIMUM OF "N" CONDITIONS.

LEGEND

POWER SYSTEMS

- GF / GF — RECESSED, WALL MOUNTED DUPLEX RECEPTACLE. 20A, 125V RATED. MOUNT 18"AFF UNO.
- RECESSED, WALL MOUNTED QUADRUPLEX RECEPTACLE. 20A, 125V RATED. MOUNT 18"AFF UNO. WHERE PRESENT, RECEPTACLE LABEL INDICATES THE FOLLOWING:
  - * - MOUNT HORIZONTALLY, 6" ABOVE COUNTERTOP.
  - GF - GFCI TYPE.
  - WP - GFCI RECEPTACLE WITH 'WEATHER PROOF WHILE IN USE' COVER.
  - CO - DEDICATED RECEPTACLE FOR COPIER EQUIPMENT.
  - R - DEDICATED RECEPTACLE FOR REFRIGERATOR.
  - TV - RECEPTACLE FOR TELEVISION MONITOR. MOUNT 6' AFF UNO.
  - WC - GFCI RECEPTACLE FOR WATER COOLER.
  - V - DEDICATED GFCI RECEPTACLE FOR VENDING MACHINE.
  - C - CLOCK RECEPTACLE. MOUNT 108" AFF UNO.
- WHERE PRESENT, RECEPTACLE SHADING INDICATES THE FOLLOWING:
  - RED POWER
  - BLACK POWER
  - SWITCHED RECEPTACLE
- NEMA L6-30R CEILING MOUNTED RECEPTACLE.
- NEMA L5-20R CEILING MOUNTED RECEPTACLE.
- RECESSED, FLOOR BOX MOUNTED DUPLEX OR QUADRUPLEX RECEPTACLE. 20A, 120V RATED.
- J — WALL MOUNTED JUNCTION BOX.
- J — FLOOR MOUNTED JUNCTION BOX.
- DISCONNECT SWITCH.
- VFD — VARIABLE FREQUENCY DRIVE. PROVIDED BY MECHANICAL DISCIPLINE. PROVIDE ELECTRICAL CONNECTION.
- (M) — METER.
- (25) — SYNCHRONIZATION CHECK
- (27) — UNDERVOLTAGE ELEMENT
- (47) — PHASE-SEQUENCE ELEMENT
- (59) — OVERVOLTAGE ELEMENT
- (81) — FREQUENCY ELEMENT
- (83) — AUTOMATIC SELECTIVE CONTROL OR TRANSFER RELAY
- POWER CIRCUIT BREAKER, DRAW-OUT TYPE
- VOLTAGE TRANSFORMER

ELECTRICAL ABBREVIATIONS

ABBREVIATION	DEFINITION
A	AMPERES
ACSR	ALUMINUM CONDUCTOR STEEL REINFORCED
AF	AMPERE FRAME OR AMPERE FUSE
AFD	ADJUSTABLE FREQUENCY MOTOR DRIVE UNIT
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
ARMS	ARC FLASH REDUCTION MAINTENANCE SWITCH
AS	AMPERE SWITCH
AT	AMPERE TRIP OR AIR TERMINAL
ATO	AUTOMATIC THROW OVER
AWG	AMERICAN WIRE GUAGE
B	BOILER
BCSD	BARE COPPER SOFT DRAWN
BFG	BELOW FINISHED GRADE
C	CONDUIT
CATV	CABLE TELEVISION
CCTV	CLOSED CIRCUIT TELEVISION
CH	CHILLER
CKT	CIRCUIT
CKT BKR	CIRCUIT BREAKER
COMM	COMMUNICATIONS
CPDB	CABLE PUNCH DOWN BLOCK
CPT	CONTROL POWER TRANSFORMER
CR	CONTROL RELAY OR CARD READER
CT	CABLE TRAY
DB	DECIBEL
DC	DOOR CONTROL
DDC	DIRECT DIGITAL CONTROLS
DISC SW	DISCONNECT SWITCH
DN	DOWN
DPDB	DATA PUNCH DOWN BLOCK
DS	DISCONNECT SWITCH OR DISTRIBUTION SECTION
DVP	DOMINION VIRGINIA POWER
E OR EXIST.	EXISTING
EA	EACH
EF	EXHAUST FAN
EM	EMERGENCY
ENCL	ENCLOSURE
EPN	EXTERNAL PORT NETWORK SWITCH
EPO	EMERGENCY POWER OFF
ERU	ENERGY RECOVERY UNIT
EXT	EXTERIOR
FA	FIRE ALARM
FAA	FIRE ALARM GRAPHIC ANNUNCIATOR
FACP	FIRE ALARM CONTROL PANEL
FO	FIBER OPTIC CABLE
FOTB	FIBER OPTIC TERMINAL BLOCK
FPS	FIRE ALARM REMOTE POWER SUPPLY
FTL	FEED THRU LUGS
FUS	FUSE
FVNR	FULL VOLTAGE NON-REVERSING
G	GROUND
GEN	GENERAL
GFI	GROUND FAULT INTERRUPTING
GP	GENERAL PURPOSE
HD	HAND TOWEL DISPENSER
HP	HORSE POWER
HPS	HIGH PRESSURE SODIUM
HT	HEAT TRACE
HWS	HOTELING WORK STATION
IDS	INTRUSION DETECTION SYSTEM
JB	JUNCTION BOX
KV	KILOVOLTS
KVA	KILOVOLT AMPERES
KW	KILOWATTS
LAN	LOCAL AREA NETWORK
LED	LIGHT EMITTING DIODE
LPS	LIGHTNING PROTECTION SYSTEM
LTG	LIGHTING
M	MAIN OR METER
MB	MAIN CIRCUIT BREAKER
MCCB	MOLDED CASE CIRCUIT BREAKER
MECH	MECHANICAL
MH	METAL HALIDE, MANHOLE, OR MOUNTING HEIGHT TO CENTER OF DEVICE

ELECTRICAL ABBREVIATIONS

ABBREVIATION	DEFINITION
MLO	MAIN LUGS ONLY
MNS	MASS NOTIFICATION SYSTEM
MP SW	MOTOR PROTECTIVE SWITCH
MS	MAGNETIC STARTER
MSB	MAIN SWITCHBOARD
MTD	MOUNTED
MTR	METER
N	NEUTRAL
NC	NORMALLY CLOSED
NE	NORTHEAST
NEC	NATIONAL ELECTRICAL CODE
NETA	NATIONAL ELECTRICAL TESTING ASSOCIATION
NF	NON-FUSED
NIC	NOT IN CONTRACT
NL	NON LINEAR
NO	NORMALLY OPEN
O.C.	ON CENTER
OS	OCCUPANCY SENSOR
P	POLE OR PRIMARY
PC	PHOTOELECTRIC CELL
PET	PROTECTED ENTRANCE TERMINAL
PH	PHASE
PNL	PANEL
PVC	POLYVINYL CLORIDE
PWR	POWER
RCPT OR RECPT	RECEPTACLE
S	SECONDARY OR SURFACE WALL MOUNTED
SC	SHORT CIRCUIT
SCC	SHORT CIRCUIT CURRENT
SE	SOUTHEAST
SEC	SECURITY
SF	SYSTEMS FURNITURE
SHT	SHEET
SO	SPACE ONLY
SSBJ	SUPPLY SIDE BONDING JUMPER
STCB	SHUNT TRIP CIRCUIT BREAKER
SW	SWITCH
SWS	STUDENT WORK STATION
SYM	SYMMETRICAL
T	THICK
TB	TERMINAL BOX
TP	COMMUNICATION PANEL
TR	COMMUNICATIONS ROOM
TS	TAMPER SWITCH
TSP	TWISTED, SHIELDED PAIR
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
TYP	TYPICAL
UH	UNIT HEATER
UNO	UNLESS NOTED OTHERWISE
UPS	UNINTERRUPTIBLE POWER SUPPLY
UTC	UNDERGROUND TELECOMMUNICATIONS CONDUIT
UTP	UNSHEILDED TWISTED PAIR
UTVC	UNDERGROUND CABLE TELEVISION CONDUIT
V	VOLTS
VFD	VARIABLE FREQUENCY DRIVE
VFI	VACUUM FAULT INTERRUPTER
W	WIRE OR WATT
WAP	WIRELESS INTERNET ACCESS POINT
WH	WATER HEATER
WP	WEATHERPROOF
WS	WORKSTATION
WS	WORKSTATION
XFMR OR T	TRANSFORMER
XMTR	TRANSMITTER
Y	WYE CONNECTED
YDCT	WYE DELTA CLOSED TRANSITION

US Army Corps of Engineers ®

Mortenson | COFFMAN ENGINEERS | SCHMIDT

MARK	DESCRIPTION	DATE
0	REVISED TO SHOW AS-BUILT CONDITIONS BIDS/DESIGN CONFIGURATION PACKAGE 'C'	12/23/2024 3/29/2024

DESIGNED BY: [redacted]
DRAWN BY: [redacted]
CHECKED BY: MRK
SUBMITTED BY: MRK
ISSUE DATE: 3/29/2024
DUPLICATION NO.
CONTRACT NO. W912HF-19-C-0006
CONTRACT NO. W912HF-19-C-0006
P.E. NUMBER:
AND/OR P.E. NAME:

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE
OMAHA, NE 68102

Wiley | Wilson

SBIRS, OPERATIONAL SUPPORT FACILITY
BUCKLEY AFB, COLORADO
PN CRWU393502

LEGENDS AND ABBREVIATIONS

SHEET ID
E-020

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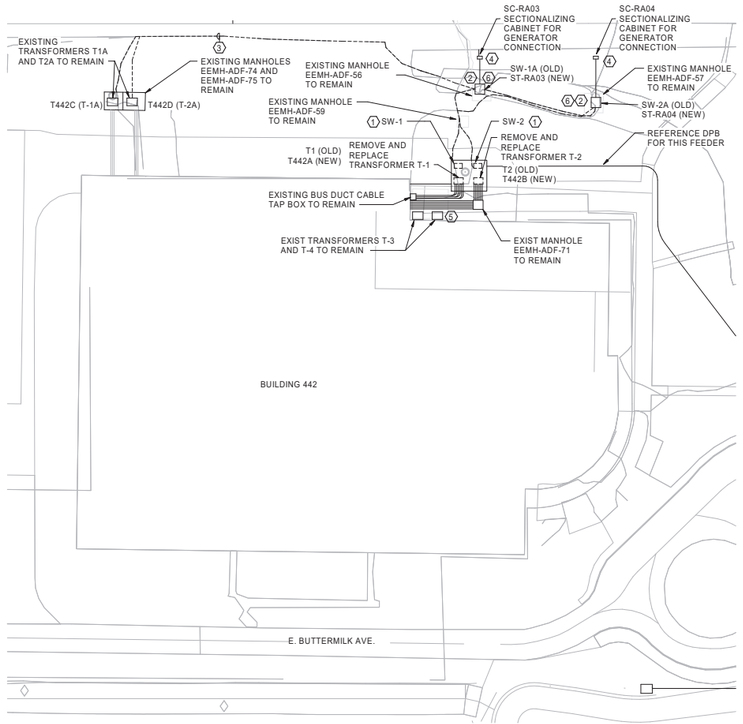


PLAN NORTH

1 ELECTRICAL SITE PLAN

SCALE: 1" = 30'-0"

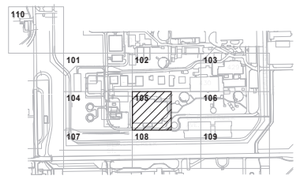
0' 15' 30' 60'

GENERAL NOTE:

1. ALL WORK SHALL BE ACCOMPLISHED IN SUCH A MANNER AS TO KEEP FACILITY SYSTEMS OPERATIONAL 100% OF THE TIME. THE FACILITY IS BASED ON REDUNDANT SOURCES OF POWER (2N). SEQUENCE THE WORK SO THAT THE EXISTING SYSTEMS REMAIN OPERATIONAL WHILE THE NEW SYSTEMS ARE INSTALLED AND OPERATIONAL, MAINTAINING A MINIMUM OF "N" CONDITIONS.

KEY NOTES:

1 REMOVE SW-1 AND SW-2
2 REMOVE AND REPLACE SW-1A AND SW-2A WITH NEW 4-WAY SWITCHES. REMOVE EXISTING FEEDERS FROM LOAD BREAK SWITCH "SW-1A" TO TRANSFORMER "T-1." REMOVE FEEDERS FROM LOAD BREAK SWITCH "SW-2A" TO TRANSFORMER T-2. REMOVE FEEDERS ASSOCIATED WITH B442 T-1 AND T-2 SUPPLIES FROM LOAD BREAK SWITCHES "SW-1A" AND "SW-2A." MANHOLE AND INFRASTRUCTURE SUPPORTING OTHER SYSTEMS SHALL REMAIN. FEEDERS UPSTREAM OF SW-1A AND SW-2A (TOWARDS B401) TO REMAIN IN PLACE.
3 REMOVE FEEDERS FROM SWITCHES SW-1A AND SW-2A TO MECHANICAL TRANSFORMERS T-1A AND T-2A. DUCT AND FEEDERS SUPPLYING OTHER LOADS TO REMAIN. REFEED TRANSFORMERS T-1A AND T-2A AS INDICATED ON THE ELECTRICAL SINGLE LINE.
4 PROVIDE FEEDER IN DUCT TO NEW SECTIONALIZING CABINETS. MOUNT SECTIONALIZING CABINETS BETWEEN 4' AND 10' FROM THE ROAD. FINAL LOCATION TO BE COORDINATED WITH BY CONTRACTOR.
5 REMOVE AND REPLACE ALL 480V FEEDERS FROM TRANSFORMERS T-1 AND T-2. EXISTING INFRASTRUCTURE MAY BE REUSED.
6 PROVIDE (2) NEW 4-WAY DEAD FRONT SWITCHES TO REPLACE EXISTING LOAD BREAK SWITCHES SW-1A AND SW-2A.



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COFFMAN ENGINEERS

SCHMIDT

MARK	DATE	DESCRIPTION
0	12/23/2024	REVISED TO SHOW AS-BUILT CONDITIONS
		ISSUED FOR CONSTRUCTION - 95% PACKAGE 'C'

USARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVE
OMAHA, NE 68102

Wiley|Wilson

DESIGNED BY: MRK
DRAWN BY: ACM
CHECKED BY: MRK
SUBMITTED BY: [illegible]
P.E. NAME: [illegible]

ISSUE DATE: 12/23/2024
DOCUMENT/DRAWING NO.
W912GF-18-R-0004
CONTRACT NO.
W912GF-19-C-0006
P.E.# NUMBER

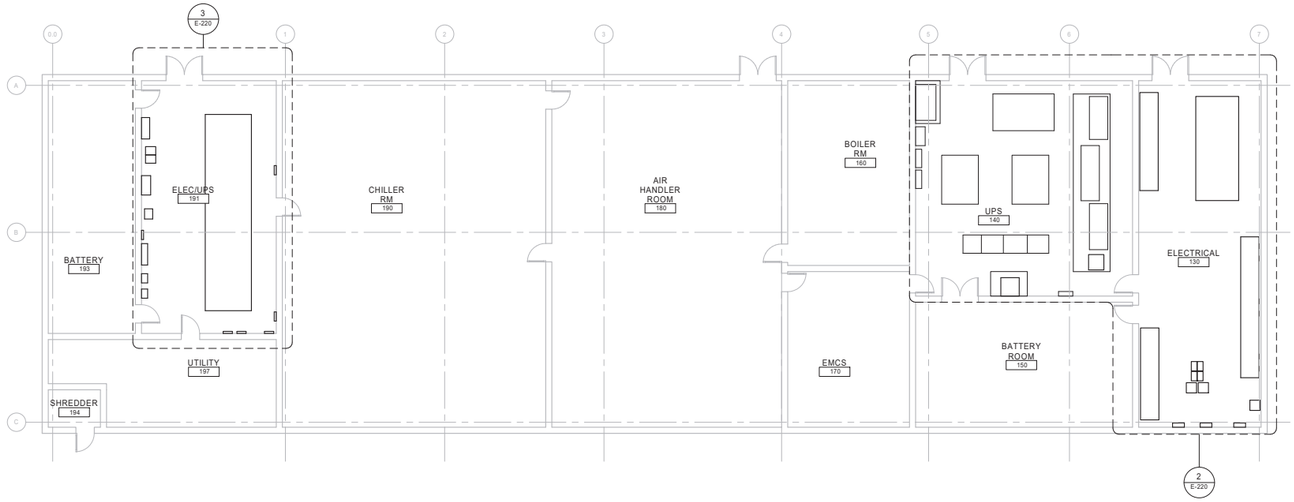
88RS - OPERATIONAL SUPPORT FACILITY
BUCKLEY AFB, COLORADO
PN CWU083002

ELECTRICAL SITE PLAN

SHEET ID

ES125

26 13 13AT1



PLAN NORTH 1 FIRST FLOOR POWER PLAN

SCALE: 1/8" = 1'-0"

GENERAL NOTE:

1. ALL WORK SHALL BE ACCOMPLISHED IN SUCH A MANNER AS TO KEEP FACILITY SYSTEMS OPERATIONAL 100% OF THE TIME. THE FACILITY IS BASED ON REDUNDANT SOURCES OF POWER (2N). SEQUENCE THE WORK SO THAT THE EXISTING SYSTEMS REMAIN OPERATIONAL WHILE THE NEW SYSTEMS ARE INSTALLED AND OPERATIONAL, MAINTAINING A MINIMUM OF "N" CONDITIONS.

KEY NOTES:

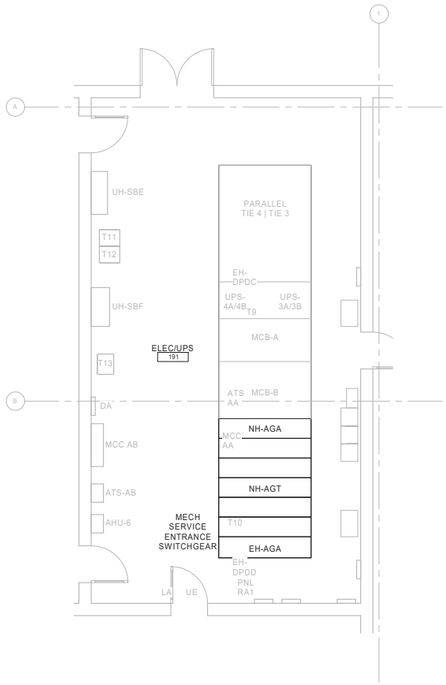
1 PROVIDE THREE SOURCE 120 VAC AUTO-SEEK CONTROL POWER SELECTION SCHEME. UTILIZE THREE (3) 277-120/240 CONTROL POWER TRANSFORMERS, ONE FED FROM EACH MAIN SUPPLY AND THE THIRD FROM A UPS PANEL.EXTEND THREE SOURCE 120VAC AUTO-SEEK CONTROL POWER FROM TECH SERVICE ENTRANCE SWITCHGEAR TO ATO PLC CABINET. SEE 1/E-520 FOR MORE INFORMATION.

2 UPS SOURCE IS TO BE UH-SBD, 1P20A BKR 27 LOCATED IN ROOM 140. PROVIDE 2X12 AWG, 1X12 AWG GND THHN CONDUCTORS ROUTED IN 3/4 INCH CONDUIT. SEE 1/E-520 FOR MORE INFORMATION.

3 IF SUFFICIENT ROOM IS NOT AVAILABLE WITHIN THE SWITCHGEAR PROVIDE A CONTROL PANEL TO HOUSE ALL RELAYS, FUSES AND OTHER REQUIRED COMPONENTS INVOLVED WITH THE AUTO-SEEK CONTROL POWER SELECTION SCHEME. SEE 1/E-520 FOR MORE INFORMATION.

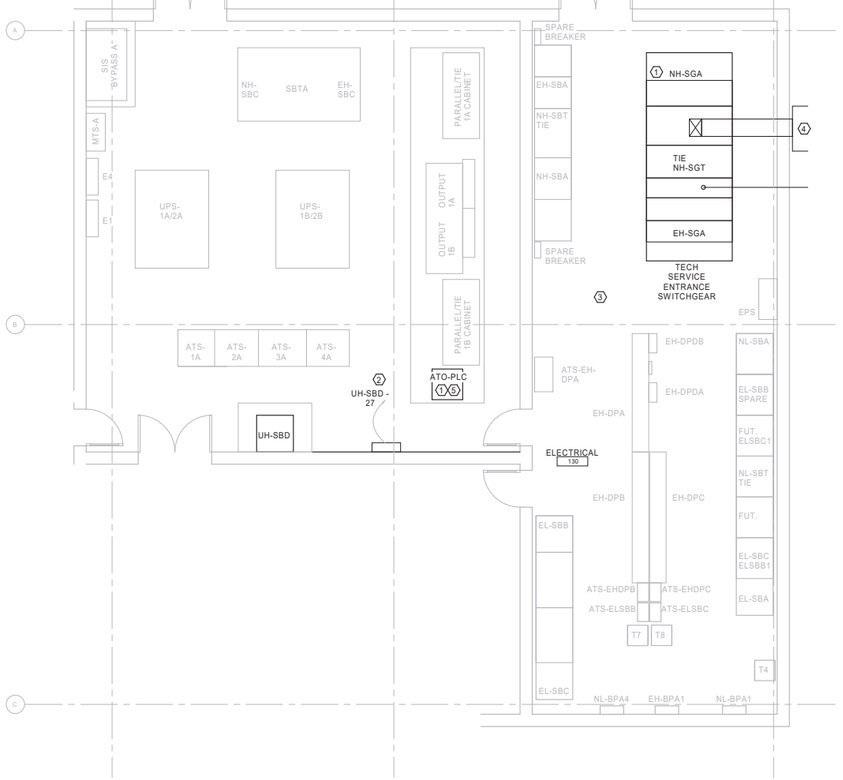
4 EXISTING BUS DUCT CABLE TAP BOX. SEE ES-125 FOR CONTINUATION.

5 PLC SHALL BE CONNECTED TO GOVERMENT FURNISHED MANAGED SWITCH (JUNIPER EX2300-C-12T-TAA) LOCATED IN EMSC ROOM 170.



PLAN NORTH 3 FIRST FLOOR POWER PLAN - ELEC/UPS 191

SCALE: 1/4" = 1'-0"



PLAN NORTH 2 FIRST FLOOR POWER PLAN - ELECTRICAL 130 AND 140

SCALE: 1/4" = 1'-0"

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US Army Corps of Engineers ®

Mortenson

COFFMAN ENGINEERS

SCHMIDT

MARK	AS-BUILT REVISIONS	DATE
1	REVISED TO SHOW AS-BUILT CONDITIONS BASED ON CONSTRUCTION OF SWITCHGEAR 'E'	2/23/2024

DESIGNED BY:	
DRAWN BY:	
CHK'D BY:	
CHECKED BY:	
MHK	
SUBMITTED BY:	
P.E. NAME	
DATE:	

ISSUE DATE:
SOLICITATION NO.
W912SF-18-R-0004
CONTRACT NO.
W912SF-19-C-0006

USACE OMAHA DISTRICT
1616 CAPITOL AVE
OMAHA, NE 68102

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POWER PLAN

SHEET ID

E-220

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GENERAL NOTE:

1. ALL WORK SHALL BE ACCOMPLISHED IN SUCH A MANNER AS TO KEEP FACILITY SYSTEMS OPERATIONAL 100% OF THE TIME. THE FACILITY IS BASED ON REDUNDANT SOURCES OF POWER (2N). SEQUENCE THE WORK SO THAT THE EXISTING SYSTEMS REMAIN OPERATIONAL WHILE THE NEW SYSTEMS ARE INSTALLED AND OPERATIONAL, MAINTAINING A MINIMUM OF "N" CONDITIONS.

NH-SGA SPACE 1A	NH-SGA SPACE 2A	NH-SGA ⊘ FUSE TRUCK 3AB	⊘ FUSE TRUCK TVSS MP 4AB	EH-SGA ⊘ FUSE TRUCK 5AB	EH-SGA SPACE 6A	EH-SGA ⊘ FUSE TRUCK 7AB	EH-SGA SPACE 8A
NH-SGA UPS BYPASS MTS A 1B	NH-SGA NH-SBA 2B				EH-SGA EH-SBA 6B		EH-SGA UPS BYPASS MTS B 8B
NH-SGA NH-SBC 1C	NH-SGA XFMR T2 2C	NH-SGA NH-SGA MAIN 52/N 3CD	TIE NH-SGT-TIE 52/T 4CD	EH-SGA EH-SGA MAIN 52/E 5CD	EH-SGA XFMR T3 6C	EH-SGA 52/E2 FUTURE 7CD	EH-SGA EH-SBC 8C
NH-SGA SPACE 1D	NH-SGA SPACE 2D				EH-SGA SPACE 6D		EH-SGA SPACE 8D

1 TECH SWITCHGEAR NH-SGA & EH-SGA
SCALE: NONE

NH-AGA TVSS	NH-AGA SPARE-1N	NH-AGA ATS-AB-N	EH-AGA RT PAD	EH-AGA ATS-AB-E	EH-AGA SPARE-1E	EH-AGA TVSS
NH-AGA NH-AGA MAIN	NH-AGA ATS-CH3-N	NH-AGA UPS SWGR-A	NH-EH AGT (TIE)	EH-AGA UPS SWGR-B	EH-AGA ATS-CH-3-E	EH-AGA EH-AGA MAIN
NH-AGA ATS-AA-N	NH-AGA ATS ROLL-UP CHILLER-N	NH-AGA MBP-3	NH-AGA ATS CH-2 N	EH-AGA MBP-4	EH-AGA ATS ROLL-UP CHILLER-E	EH-AGA ATS-AA-E
NH-AGA ATS CH-1-N	NH-AGA SPARE-2N	NH-AGA MCS BYPASS	NH-AGA	EH-AGA ATS-CH-2-E	EH-AGA SPARE-2E	EH-AGA ATS-CH-1-E

2 MECH SWITCHGEAR NH-AGA & EH-AGA
SCALE: NONE

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COFFMAN ENGINEERS
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MARK	DATE	DESCRIPTION
0	12/23/2024	REVISED TO SHOW AS-BUILT CONDITIONS
	8/30/2024	95% DESIGN SUBMITTAL - PACKAGE 1C

DESIGNED BY:
DRAWN BY:
Author
CHECKED BY:
Checker
SUBMITTED BY:
PM
ISSUE DATE:
CONSTRUCTION NO.
W912F-18-R-0004
CONTRACT NO.
W912F-19-C-0006
P2 E NUMBER:

USACE / NWO
LIEUTENANT COLONEL
ANDREW M. NAPOLITANO

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ARCHITECTURE | ENGINEERING

SBIRS, OPERATIONAL SUPPORT FACILITY
BUCKLEY AFB, COLORADO
PN CWW3093002

SWITCHGEAR ELEVATIONS

SHEET ID
E-320

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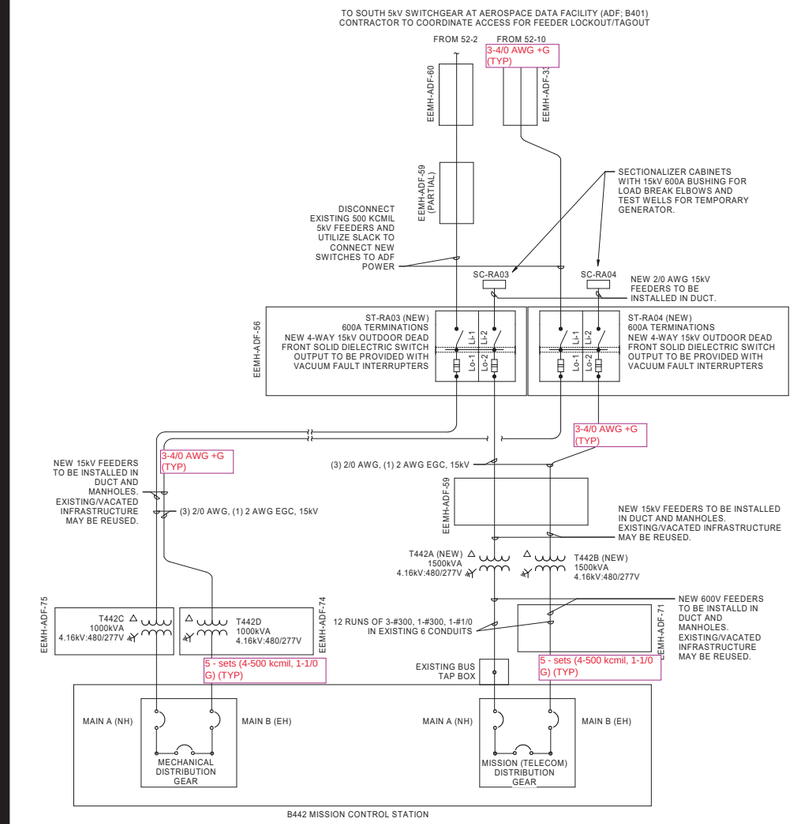
GENERAL NOTE:

1. ALL WORK SHALL BE ACCOMPLISHED IN SUCH A MANNER AS TO KEEP FACILITY SYSTEMS OPERATIONAL 100% OF THE TIME. THE FACILITY IS BASED ON REDUNDANT SOURCES OF POWER (2N). SEQUENCE THE WORK SO THAT THE EXISTING SYSTEMS REMAIN OPERATIONAL WHILE THE NEW SYSTEMS ARE INSTALLED AND OPERATIONAL, MAINTAINING A MINIMUM OF "N" CONDITIONS.



2 NEW AREA ELECTRICAL UTILITY ONE LINE
SCALE: NONE

US Army Corps of Engineers ®

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COFFMAN ENGINEERS

SCHMIDT

MARK	DESCRIPTION	DATE
0	95% SUBMITTAL REVISIONS	20230502
	REVISED TO SHOW AS-BUILT CONDITIONS BASED ON CONTRACTOR AS-BUILT MARKUPS	20230802

DESIGNED BY: MJK
DRAWN BY: KCM
CHECKED BY: MJK
SUBMITTED BY: MJK
ISSUE DATE: 20230502
P.E. NAME:
P.E. NUMBER:

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Wiley|Wilson

SBIRS: OPERATIONAL SUPPORT FACILITY
BUCKLEY AFB, COLORADO
PN CRWU09302

AREA ELECTRICAL UTILITY ONE LINES

SHEET ID
E-620

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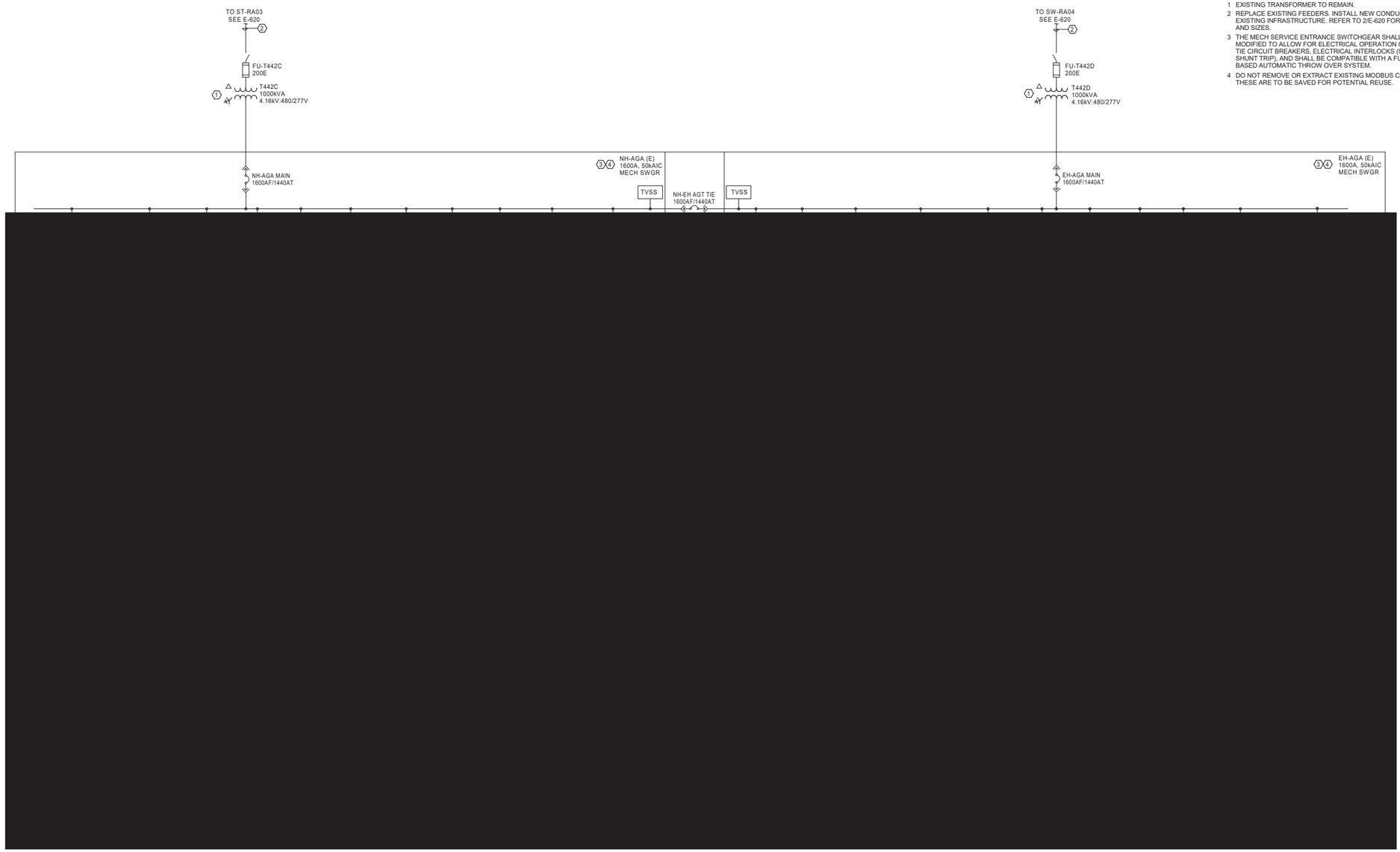
GENERAL NOTE:

1. ALL EQUIPMENT SHOWN ON THIS SHEET IS EXISTING AND MODIFIED ONLY AS INDICATED.
2. UNDERGROUND CABLE SPLICES ARE NOT PERMITTED.
3. ALL WORK SHALL BE ACCOMPLISHED IN SUCH A MANNER AS TO KEEP FACILITY SYSTEMS OPERATIONAL 100% OF THE TIME. THE FACILITY IS BASED ON REDUNDANT SOURCES OF POWER (2N). SEQUENCE THE WORK SO THAT THE EXISTING SYSTEMS REMAIN OPERATIONAL WHILE THE NEW SYSTEMS ARE INSTALLED AND OPERATIONAL; MAINTAINING A MINIMUM OF "N" CONDITIONS.

KEY NOTES:

1 EXISTING TRANSFORMER TO REMAIN.
2 REPLACE EXISTING FEEDERS. INSTALL NEW CONDUCTORS IN EXISTING INFRASTRUCTURE. REFER TO 2/E-620 FOR QUANTITY AND SIZES.
3 THE MECH SERVICE ENTRANCE SWITCHGEAR SHALL BE MODIFIED TO ALLOW FOR ELECTRICAL OPERATION OF MAIN AND TIE CIRCUIT BREAKERS, ELECTRICAL INTERLOCKS (STANDING SHUNT TRIP), AND SHALL BE COMPATIBLE WITH A FUTURE PLC BASED AUTOMATIC THROW OVER SYSTEM.
4 DO NOT REMOVE OR EXTRACT EXISTING MODBUS CONVERTERS. THESE ARE TO BE SAVED FOR POTENTIAL REUSE.



1 MECHANICAL SERVICE ONE LINE
SCALE: NONE

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COFFMAN ENGINEERS
SCHMIDT

NO.	DATE	REVISION DESCRIPTION
0	12/23/2020	REVISED TO SHOW AS BUILT CONDITIONS

ISSUE DATE: 12/23/2020
SOLICITATION NO.
W912NF-18-R-0004
CONTRACT NO.
W912NF-19-C-0006
P.E.I. NUMBER

DESIGNED BY:	
DRAWN BY:	KZM
CHECKED BY:	MRK
SUBMITTED BY:	
P.E.I. NAME:	

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1616 CAPITOL AVE
OMAHA, NE 68102

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SBIRS OPERATIONAL SUPPORT FACILITY
BUCKLEY AFB, COLORADO
PN:CWV0B30002

MECHANICAL SERVICE ONE LINE

SHEET ID
E-621

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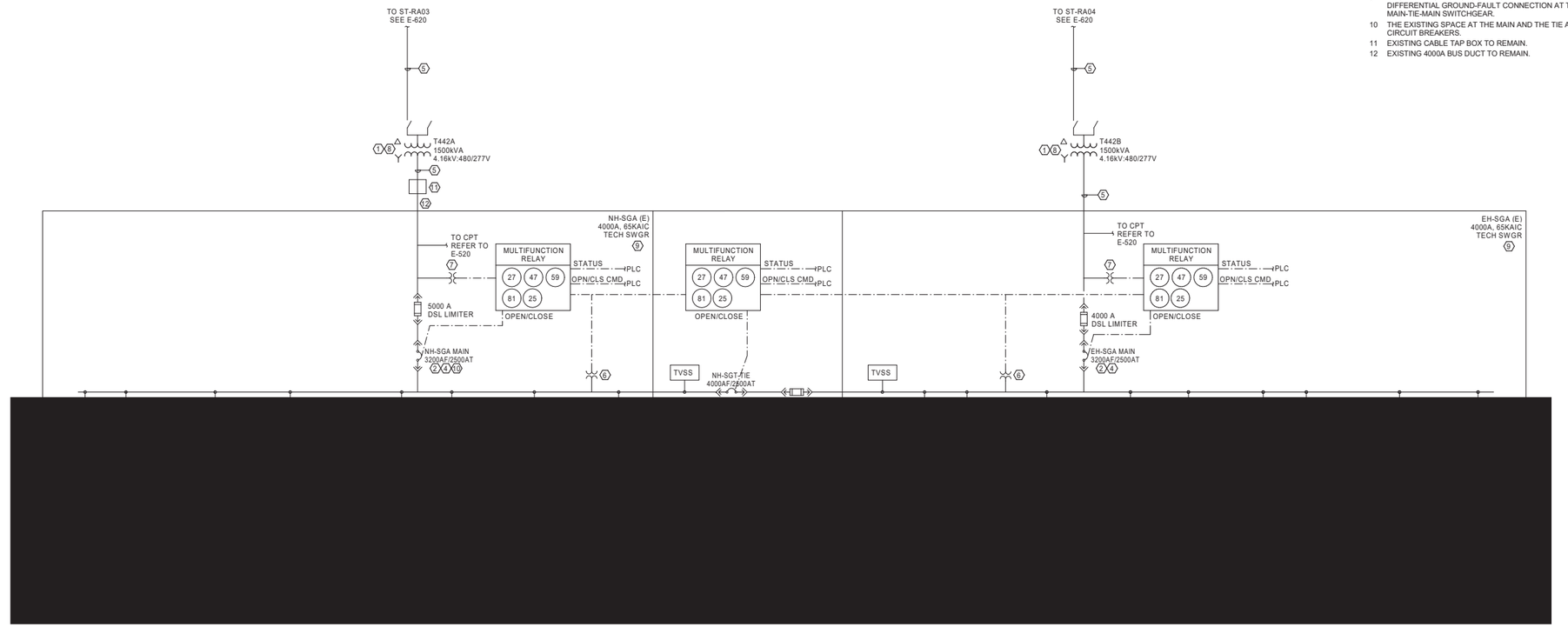
GENERAL NOTE:

1. UNDERGROUND CABLE SPLICES ARE NOT PERMITTED.
2. ALL WORK SHALL BE ACCOMPLISHED IN SUCH A MANNER AS TO KEEP FACILITY SYSTEMS OPERATIONAL 100% OF THE TIME. THE FACILITY IS BASED ON REDUNDANT SOURCES OF POWER (2N). SEQUENCE THE WORK SO THAT THE EXISTING SYSTEMS REMAIN OPERATIONAL WHILE THE NEW SYSTEMS ARE INSTALLED AND OPERATIONAL; MAINTAINING A MINIMUM OF "N" CONDITIONS.

KEY NOTES:

1 PROVIDE NEW OIL-FILLED TRANSFORMERS. REMOVE EXISTING TRANSFORMERS FEEDING THE TECH SERVICE ENTRANCE SWITCHGEAR. PROVIDE LIQUID-FILLED TRANSFORMERS WITH UNDER OIL SWITCH, AND LOOP-FEED CAPABILITIES.
2 REPLACE CM2250 POWER METERS ON SERVICE ENTRANCE MAIN BREAKERS WITH ION 7650 OR EQUAL POWER METERS.
3 REMOVE CM2250 METERS ON FEEDER BREAKERS.
4 PROVIDE DIRECT REPLACEMENT RETROFIT CIRCUIT BREAKERS. CIRCUIT BREAKERS SHALL INCLUDE LSIG FUNCTIONALITY, METERING, ELECTRICAL OPERATION, ELECTRICAL INTERLOCKS (STANDING SHUNT TRIP), AND BE COMPATIBLE WITH PLC-BASED AUTOMATIC THROW OVER SYSTEM. SENSOR RATINGS SHALL MATCH FRAME RATING SHOWN.
5 REPLACE EXISTING FEEDERS. INSTALL NEW CONDUCTORS IN EXISTING INFRASTRUCTURE. REFER TO 2/E-620 FOR QUANTITY AND SIZES.
6 EXISTING SET OF 3 VOLTAGE TRANSFORMERS, 2.4:1 RATIO, ON SWITCHGEAR BUS. REWIRE AS REQUIRED TO SUPPORT SYNC CHECK AND AUTOMATION.
7 PROVIDE SET OF 3 VOLTAGE TRANSFORMERS, 2.4:1 RATIO, ON LINE SIDE OF MAIN CIRCUIT BREAKER TO SUPPORT SYNC CHECK AUTOMATION.
8 REMOVE EXISTING NEUTRAL-GROUND BOND.
9 PROVIDE NEUTRAL GROUND BOND AND A MODIFIED DIFFERENTIAL GROUND-FAULT CONNECTION AT THE MAIN-TIE-MAIN SWITCHGEAR.
10 THE EXISTING SPACE AT THE MAIN AND THE TIE ARE FOR 4000AF CIRCUIT BREAKERS.
11 EXISTING CABLE TAP BOX TO REMAIN.
12 EXISTING 4000A BUS DUCT TO REMAIN.



1 TECH SERVICE ONE LINE
SCALE: NONE

DESIGNED BY: MW
DRAWN BY: PCM
CHECKED BY: MWK
SUBMITTED BY: JNE
ISSUE DATE: 07/31/2020
SOLICITATION NO.: W912BF-18-R-0004
CONTRACT NO.: W912BF-19-C-0006
P.E. NUMBER: P.E. NAME:

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1616 CAPITOL AVE
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Wiley|Wilson

88RS, OPERATIONAL SUPPORT FACILITY
BUCKLEY AFB, COLORADO
PN:CWU089002

TECH SERVICE ONE LINE

SHEET ID
E-622

US Army Corps of Engineers ®
Mortenson
COFFMAN ENGINEERS
SCHMIDT

DATE | DESCRIPTION | MARK

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Power Independence,
Mission Control Station
Buckley, SFB, Colorado

Sequence of Operation

Dual Transfer Pair

Paralleling Switchgear

Revision 2.0

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1 Power System Components

Component	Name(s) or Description
Generator Set	GA1, GA2, GB1, GB2
Generator Set Breaker	52-GA1, 52-GA2, 52-GB1, 52-GB2
Utility Main Breaker	52-UMA, 52-UMB
Generator Main Breaker	52-GM1, 52-GM2
Feeder Breaker	52-F1 through 52-Fx
Transfer Pair	Consists of a Utility Main and a Generator Set Main Breaker Pair
Genbus	The bus on which Generator Sets start and parallel.
Loadbus	The bus on which loads to be serviced reside.
PowerCommand Control (PCC)	PCC3100, PCC3201, PCC3300 The Generator Set control system which monitors and performs all of the control and protection functions of the Generator Set.
First Start System	An integrated part of the PCC that inhibits all but the first Generator Set that is ready to load from closing to the Loadbus. A Generator Set is considered ready to load when it is at 90% of rated voltage and frequency. All other Generator Sets in the system are then required to synchronize to the Loadbus before closing their Generator Set breakers.
Digital Master Control (DMC)	The control enclosure that houses the DMC and the operator Human – Machine Interface (HMI)

2 Definitions

Name	Description
HMI Control Selection	The Control Selection defines the source of System Control. When the Control Selection is: **Operator-** User can manually control the system control sequences from any DMC HMI, including the Web. **Hardwired Inputs** – It allows the system to enter Test with Load and use the customer inputs to the DMC to trigger the relevant mode. Hardwired Inputs is selectable only when the system mode is Off. **Scheduler** - Select to allow the scheduled events set up in the Scheduler screen to run. Scheduler control is selectable only when the system mode is Off.
Loadbus Selection	The operator is able to select which Loadbus (ses) will be active in the Test with Load. At least one Loadbus must be chosen to enable the Test with Load mode.
HMI System Mode	The system mode indicates the current operating mode of the DMC. Typically, this mode is set to Off. When the System Mode is set to Off, the DMC is in Standby, ready to respond to a Normal Source Failure. The operator is able to set the system mode: Test without Load, Test with Load.

HMI Transition Type	The transition type determines the method of power transfer between the sources. **Auto – Open Transition**- The DMC performs break-before-make transition transfers and retransfers. The loads will be not powered for the duration of the programmed transition delay. **Auto – Soft Closed Transition** - The DMC performs make-before-break transition transfers and retransfers. The DMC will ramp the load between sources with no interruption. **Manual**- The DMC disables all automatic control operations, i.e., the entire system is placed in a Not in Automatic mode and provides operator initiated control of the DMC. The operator can request the DMC to open and close breakers, and start and parallel generators. This mode does not allow closed transition transfers.
Time Delays	Time delays ensure the system is safe and stable before performing a transition. The following time delays are unique for each transfer pair. **Programmed Transition Delay** - (Range: 1-60 Sec) This is the time period that both sources remain open during an open transition transfer to allow spinning loads to decay to a safe level before the transition. It is initiated when no source is connected and the DMC is in a transfer or retransfer process. **Transfer Delay** - (Range: 0-12 Sec) This is the time period that the system waits before transferring to the generator source. It allows time for the Utility to recover from a momentary power outage and for the generator source to stabilize before transferring the load. It is initiated when the minimum generator capacity required is online. **Retransfer Delay** - (Range: 1-120 Min) This is the time period that the Utility must be available before the system transfers the load from the generators to the utility. It allows time for the Utility to stabilize before transferring the load. It is initiated when the generator bus is connected and Utility source becomes available, in normal condition. **Utility Fail Delay** - (Range: 0-10 Sec) The amount of time that the DMC waits after recognizing a Utility failure signal before it initiates a transfer to the Generator Sets. It prevents the transfer during temporary Utility failure. **Min. Capacity to Connect Time Out** - (Range: 30-600 Sec) The time is used to initiate an alarm if the minimum capacity has not been reached when the Generator Sets are signaled to start. The following Time Delays are applicable to the entire system. **Load Add - Genbus Delay** - (Range: 0-60 Sec) This is the time delay between load add levels when the source is Generator Sets. **Load Add - Utility Delay** - (Range: 0-60 Sec) This is the time delay between load add levels when the source is Utility. **Load Shed - Shed Delay** - (Range: 0.1-10 Sec) This is the time delay between load shed levels when the source is Generator Sets during the bus overload condition. **Max Ramp Time** - (Range: 10-180 Sec) The maximum ramp time is used to predict the amount of the time the system should ramp load up or down. When the time expires, the system disconnects the paralleled sources.
Unload kW Threshold	The DMC uses the Unload kW threshold to determine when to open the 52-UM or 52-GM breaker during soft closed transition transfers. This setting is unique for each transfer pair.
Min. Capacity to Connect	It is the minimum amount of spare capacity required to connect the Generator Sets to the Loadbus via a Generator Main (52-GM) breaker.

	This setting is used to make sure enough generation is available to serve the Loadbus upon connection to Generator Sets. This setting is unique for each transfer pair.
Required Online Capacity	The Required Online Capacity is an adjustable setting which is a user defined estimate of the total kW consumed when all loads are added to the Loadbus. When the capacity of the Generator Sets connected to the Loadbus is at or exceeds the Required Online Capacity, it is assumed that enough generation exists to power all loads in the system. If all the Generator Sets are online, it is assumed that the Required Online Capacity is met. This threshold is used to start timed load adding in the system when more Load Add Levels exist than number of Generator Sets in the system. This setting is unique for each transfer pair.
Load Dump	The PCC generates the Load Dump signal based on the parameters defined by the settings in each PCC. Default Settings are: Overload - 105% (Range: 80-140%) Overload Time - 60 Sec (Range: 0-120 Sec) Under Frequency Offset - 3 Hz (Range: 0-10 Hz) Under Frequency Time - 3 Sec (Range: 0-20 Sec)

3 System Modes

3.1 Normal Standby Conditions

- Utility Sources are available and the Utility Main breakers 52-UMA and 52-UMB are closed.
- Generator Main Breakers 52-GM1 and 52-GM2 are open.
- Breakers 52-T1, 52-T2, 52-T3 , 52-T5, 52-GMA, and 52-GMB are closed.
- Breakers 52-T4 and 52-T6 are open.
- Generator Set breakers are open and the Generator Sets are not running.
- All Generator Sets are in Auto at each Generator Set PowerCommand Control.
- Feeder Breakers are connected and in the closed position.
- Load Bank Breakers 52-F8 and 52-F2 are open.
- System Mode is set to Off.
- Transition Type is set to Auto - Open Transition or Auto - Soft Closed Transition.
- When any generator is called to start, a signal is sent to the DDC (A/B/C) Mech panel(s) to indicate which generator is running so that the respective supply side fan(s) can turn on and the respective damper(s) can open.
- When any generator is called to stop, a signal is sent to the DDC (A/B/C) Mech panel(s) to stop to indicate which generator has stopped so that the respective supply side fan(s) can stop and the respective damper(s) can close.
- If smoke is detected the mechanical control system will send the DMC a command to stop generators.

3.2 Single Utility Source Failure

Loss of a single Utility Source sequences described below are applicable to either transfer pair when there is a single utility source failure. For these sequences the DMC will use the applicable time delays and other configurable settings that are unique for each transfer pair. In the following sequences 52-UM, 52-GM and Loadbus refer to the respective transfer pair.

3.2.1 Loss of a Single Utility Source (Auto – Open or Auto – Soft Closed Transition)

1. The DMC receives a single loss of Utility Source signal from the device monitoring the Utility Source.
2. A configurable Utility Fail Delay within the DMC times and expires.
3. The DMC sends a start signal to all the Generator Sets.
4. Minimum Capacity to Connect to Loadbus timer starts. (The Generator Set's start signal will be removed if the Minimum Capacity to Connect is not reached before the timer expires. Operator Intervention is required at this point.)
5. Generator Sets start automatically, independently, and accelerate to rated voltage and frequency. Signal is sent to the DDC (A/B/C) Mech panel to start the respective supply side fans and open respective dampers.
6. The first Generator Set closes to the bus as dictated by the First Start System.
7. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
8. A configurable Transfer Delay starts in the DMC when the Minimum Capacity to Connect to Loadbus is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
9. When the configurable Transfer Delay expires, the DMC commands the 52-UM breaker to open, and the 52-UM breaker opens.
10. All the feeder breakers not assigned to Shed Level 0 are commanded to open.
11. After the 52-UM breaker opens, a configurable Programmed Transition Delay starts in the DMC.
12. After the configurable Programmed Transition Delay expires, the DMC verifies that Minimum Capacity to Connect to Loadbus is still true.
13. The DMC commands the 52-GM breaker to close, the 52-GM breaker closes.
14. The Loadbus is powered by Generator Set source.
15. Normal Load Add sequence starts as described in *Load Add Sequence during Loss of Utility Source.*
16. Load Demand operates if enabled as described in *Load Demand*.

3.2.2 Return of a Single Utility Source (Auto – Open Transition)

1. The DMC detects the removal of the loss of Utility Source signal from the device monitoring the Utility Source.
2. A configurable Retransfer Delay starts in the DMC. Retransfer Delay can be bypassed using the Bypass Push Button available at the DMC Main One line Screen.

3. When the configurable Retransfer Delay expires, the DMC commands the 52-GM breaker to open, and the 52-GM breaker opens.
4. After the 52-GM breaker opens, a configurable Programmed Transition Delay starts in the DMC.
5. All the feeder breakers not assigned to Shed Level 0 are commanded to open. *(Refer to Open Transition Utility Transfer Load Shed (Selectable at the HMI)).*
6. When the configurable Programmed Transition Delay expires, the DMC commands the 52-UM breaker to close, and the 52-UM breaker closes.
7. Normal Load Add sequence starts as described in *Load Add Sequence during Return to Utility Source.*
8. The Loadbus is powered by the Utility Source.
9. The DMC removes the start signals from all the Generator Sets.
10. The PCC opens the Generator Set breakers.
11. The Generator Sets run in cool down mode and stop. Signal is sent to the DDC (A/B/C) Mech panel to stop the respective supply side fan(s) and close respective damper(s) once generator sets have shut down.
12. The system is now in the *Normal Standby Conditions.*

3.2.3 Return of a Single Utility Source (Auto – Soft Closed Transition)

1. The DMC detects the removal of the loss of Utility Source signal from the device monitoring the Utility Source.
2. A configurable Retransfer Delay starts in the DMC.
3. When the configurable Retransfer Delay expires, the master synchronizer is enabled between the Utility Source and the Genbus to synchronize the Generator Sets to the Utility Source.
4. Once the Generator Sets synchronize to the Utility Source and the sync check conditions are met for the 52-UM breaker, the DMC commands the 52-UM breaker to close, and the 52-UM breaker closes.
5. Generator Sets ramp down.
6. When the load across the 52-GM breaker is below the Unload kW threshold (default 50kW, configurable), the DMC commands the 52-GM breaker to open, and the 52-GM breaker opens.
7. The Loadbus is powered by the Utility Source.
8. The DMC removes the start signals from all the Generator Sets.
9. The PCC opens the Generator Set breakers.
10. The Generator Sets run in cool down mode and stop. Signal is sent to the DDC (A/B/C) Mech panel to stop the respective supply side fan (s) and respective damper(s) once the generator sets have shut down.
11. The system is now in the *Normal Standby Conditions.*

3.3 Dual Utility Source Failures

The DMC will use the applicable time delays and other configurable settings defined for each transfer pair in the following sequences. The transfer priority of the Loadbusses is set so that Loadbus 1 has higher priority.

3.3.1 Loss of Both Utility Sources (Auto – Open or Auto – Soft Closed Transition)

1. The DMC receives the loss of Utility Source signals from the devices monitoring the Utility Source 1 and Utility Source 2. The Loadbus Requires Gen Service variables are set for each Loadbus at this time.
2. Configurable Utility Fail Delays within the DMC time and expire.
3. The DMC sends a start signal to all the Generator Sets when any Utility Fail Delay expires.
4. Minimum Capacity to Connect to Loadbus timers start (If the Minimum Capacity to Connect is not reached for Loadbus 1 and it is not reached for Loadbus 2 before the timer expires the start signal will be removed. Operator Intervention is required at this point.)
5. Generator Sets start automatically, independently, and accelerate to rated voltage and frequency. Signal is sent to the DDC (A/B/C) Mech panel to start the respective supply side fans and open respective dampers.
6. The first Generator Set closes to the bus as dictated by the First Start System.
7. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
8. A configurable Transfer Delay starts in the DMC when the Minimum Capacity to Connect to each Loadbus is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
9. If both Loadbusses require Generator service, Loadbus 1 must either lose the requirement for Generator service, transfer to the Generator source or fail to transfer before it relinquishes priority and allows the Loadbus 2 to take priority. If the Loadbus 2 is ready to transfer before the Loadbus 1 it will wait for the Loadbus 1 to relinquish priority.
10. When the configurable Transfer Delay expires for the first transfer pair, the DMC commands the 52-UM1 breaker to open, and the 52-UM1 breaker opens.
11. All the feeder breakers not assigned to Shed Level 0 are commanded to open on the Loadbus 1.
12. After the 52-UM1 breaker opens, a configurable Programmed Transition Delay for first transfer pair starts in the DMC.
13. After the configurable Programmed Transition Delay expires, the DMC verifies that Minimum Capacity to Connect to Loadbus 1 is still true.
14. The DMC commands the 52-GM1 breaker to close, the 52-GM1 breaker closes.
15. The Loadbus 1 is powered by Generator Set source.
16. All the feeder breakers assigned to Load add Level 1 for Loadbus 1 are commanded to close.
17. The DMC monitors completion status of the Transfer Delay for the second transfer pair that requires Generator service.

18. The DMC commands the 52-UM2 to open, the 52-UM2 breaker opens.
19. All the feeder breakers not assigned to Shed Level 0 are commanded to open on the Loadbus 2.
20. After the 52-UM2 breaker opens, a configurable Programmed Transition Delay for the second transfer pair starts in the DMC.
21. After the configurable Programmed Transition Delay expires, the DMC verifies that Minimum Capacity to Connect to Loadbus 2 is still true.
22. The DMC commands the 52-GM2 breaker to close, the 52-GM2 breaker closes.
23. Normal Load Add sequence starts as described in *Load Add Sequence during Loss of Utility Source.*
24. Load Demand operates if enabled as described in *Load Demand*.

3.3.2 Return of a Single Utility Source following Loss of both Utility Sources (Auto – Open Transition)

1. The DMC detects the removal of the loss of Utility Source signal from the device monitoring the Utility Source.
2. A configurable Retransfer Delay starts in the DMC for the available Utility Source. Retransfer Delay can be bypassed using the Bypass Push Button available at the DMC Main One line Screen.
3. When the configurable Retransfer Delay expires, the DMC commands the 52-GM breaker to open, and the 52-GM breaker opens.
4. After the 52-GM breaker opens, a configurable Programmed Transition Delay starts in the DMC.
5. All the feeder breakers not assigned to Shed Level 0 are commanded to open. *(Refer to Open Transition Utility Transfer Load Shed (Selectable at the HMI)).*
6. When the configurable Programmed Transition Delay expires, the DMC commands the 52-UM breaker to close, and the 52-UM breaker closes.
7. Normal Load Add sequence starts as described in *Load Add Sequence during Return to Utility Source.*
8. The Loadbus is powered by the Utility Source.
9. The Generators stay connected to the Loadbus that still requires Generator service.

3.3.3 Return of both Utility Sources (Auto – Open Transition)

1. The DMC detects the removal of the loss of Utility Source signals from the devices monitoring the Utility Source 1 and Utility Source 2.
2. Configurable Retransfer Delays start in the DMC. Retransfer Delay can be bypassed using the Bypass Push Button available at the DMC Main One line Screen. The Retransfer Delay may start and expire at different times depending on when the Utility Source returns and the length of the respective Retransfer Delay.
3. When the configurable Retransfer Delays expire, the DMC commands the respective 52-GM breakers to open, and the 52-GM breakers open.
4. After the 52-GM breakers open, a configurable Programmed Transition Delay for each transfer pair starts in the DMC.

5. All the feeder breakers not assigned to Shed Level 0 are commanded to open. *(Refer to* Open Transition Utility Transfer Load Shed (Selectable at *the HMI).*
6. When the configurable Programmed Transition Delay expires, the DMC commands the respective 52-UM breakers to close, and the 52-UM breakers close.
7. Normal Load Add sequence starts as described in *Load Add Sequence during Return to Utility Source.*
8. The Loadbusses are powered by their respective Utility Source.
9. The DMC removes the start signals from all the Generator Sets.
10. The PCC opens the Generator Set breakers.
11. The Generator Sets run in cool down mode and stop. Signal is sent to the DDC (A/B/C) Mech panel to stop the respective supply side fan (s) and respective damper(s) once the generator sets have shut down.
12. The system is now in the *Normal Standby Conditions*.

3.3.4 Return of a Single Utility Source following Loss of both Utility Sources (Auto – Soft Closed Transition)

1. The DMC detects the removal of the loss of Utility Source signal from the device monitoring the Utility Source.
2. A configurable Retransfer Delay starts in the DMC.
3. When the configurable Retransfer Delay expires, the master synchronizer is enabled between the Utility Source and the Genbus to synchronize the Generator Sets to the Utility Source.
4. Once the Generator Sets synchronize to the Utility Source and the sync check conditions are met for the 52-UM breaker, the DMC commands the 52-UM breaker to close, and the 52-UM breaker closes.
5. Generator Sets ramp down.
6. When the load across the 52-GM breaker is below the Unload kW threshold (default 50kW, configurable), the DMC commands the 52-GM breaker to open, and the 52-GM breaker opens.
7. The Loadbus is powered by the Utility Source.
8. The Generators stay connected to the Loadbus that still requires Generator service.

3.3.5 Return of both Utility Sources (Auto – Soft Closed Transition)

1. The DMC detects the removal of the loss of Utility Source signals from the devices monitoring the Utility Source 1 and Utility Source 2.
2. A configurable Retransfer Delay starts in the DMC one for each Transfer Pair. Retransfer Delay can be bypassed using the Bypass Push Button available at the DMC Main One line Screen. The Retransfer Delay may start and expire at different times depending on when the Utility Source returns and the length of the respective Retransfer Delay.
3. If the Retransfer Delay expires for both the transfer pairs at the same time, Loadbus 1 will be retransferred to the Utility Source first.
4. When the configurable Retransfer Delay expires for the first transfer pair, the master synchronizer is enabled between that Utility Source and the Genbus to synchronize the Generator Sets to the Utility Source.

5. Once the Generator Sets synchronize to the Utility Source and the sync check conditions are met for the 52-UM breaker, the DMC commands the 52-UM breaker to close, and the 52-UM breaker closes.
6. When the load across the 52-GM breaker is below the Unload kW threshold (default 50kW, configurable), the DMC commands the 52-GM breaker to open, and the 52-GM breaker opens.
7. Normal Load Add sequence starts as described in *Load Add Sequence during Return to Utility Source.*
8. When the configurable Retransfer Delay expires for the other transfer pair, the master synchronizer is enabled between that Utility Source and the Genbus to synchronize the Generator Sets to the Utility Source.
9. Once the Generator Sets synchronize to the Utility Source and the sync check conditions are met for the 52-UM breaker, the DMC commands the 52-UM breaker to close, and the 52-UM breaker closes.
10. When the load across the 52-GM breaker is below the Unload kW threshold (default 50kW, configurable), the DMC commands the 52-GM breaker to open, and the 52-GM breaker opens.
11. Normal Load Add sequence starts as described in *Load Add Sequence during Return to Utility Source.*
12. The Load buses are powered by their respective Utility Source.
13. The DMC removes the start signals from all the Generator Sets.
14. The PCC opens the Generator Set breakers.
15. The Generator Sets run in cool down mode and stop. Signal is sent to the DDC (A/B/C) Mech panel to stop the respective supply side fan(s) and respective damper(s) once the generator sets have shut down.
16. The system is now in the *Normal Standby Conditions*.

3.4 Test Modes

Test modes may be initiated from different sources. All tests may be initiated from the DMC System Control Screen if the control selection is set to Operator. Test without load or test with load may be initiated from the system scheduler if a test is scheduled and the control selection is set to Scheduler. Test with load may be initiated from an external hardwired input if the control selection is set to Hardwired Inputs and the hardwired test input contact is closed.

3.4.1 Test without Load On (Auto – Open or Auto – Soft Closed Transition)

1. The system is commanded to enter into Test without Load.
2. The DMC sends a start signal to all the Generator Sets.
3. Generator Sets start automatically, independently, and accelerate to the rated voltage and frequency. Signal is sent to the DDC (A/B/C) Mech panel to start the respective supply side fans to open the respective dampers.
4. The first Generator Set closes to the bus as dictated by the First Start System.
5. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronized conditions are met within each PowerCommand Control.

6. The 52-GM breaker will remain open.
7. Load Demand operates if enabled as described in *Load Demand*.

3.4.2 Test without Load Off (Auto – Open or Auto – Soft Closed Transition)

1. The system test command is removed from the system.
2. The start signals to the Generator Sets are turned off by the DMC.
3. The PCC opens the Generator Set breakers.
4. The Generator Sets run in cool down mode and stop. Signal is sent to the DDC (A/B/C) Mech panel to stop the respective supply side fan(s) and the respective damper(s) once the generator sets have shut down.
5. The system is now in the *Normal Standby Conditions.*

3.4.3 Test with Load On (Auto – Open Transition)

The operator can make a selection for which Loadbus to be tested at the DMC System Control Screen. Following Test with Load sequence is applicable to either transfer pair when there is a single Loadbus test.

1. The system is commanded to enter into Test with Load.
2. The DMC sends a start signal to all the Generator Sets.
3. Minimum Capacity to Connect to Loadbus timer starts. (The Generator Sets start signal will be removed if the Minimum Capacity to Connect is not reached before the timer expires. Operator Intervention is required at this point.)
4. Generator Sets start automatically, independently, and accelerate to the rated voltage and frequency.
5. The first Generator Set closes to the bus as dictated by the First Start System.
6. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
7. A configurable Transfer Delay starts in the DMC when the Minimum Capacity to Connect to Loadbus is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
8. When the configurable Transfer Delay expires, the DMC commands the 52-UM breaker to open, and the 52-UM breaker opens.
9. All the feeder breakers not assigned to Shed Level 0 are commanded to open.
10. After the 52-UM breaker opens, a configurable Programmed Transition Delay starts in the DMC.
11. After the configurable Programmed Transition Delay expires, the DMC verifies that Minimum Capacity to Connect to Loadbus is still true.
12. The DMC commands the 52-GM breaker to close, the 52-GM breaker closes and Minimum Capacity to Connect to Loadbus timer stops and resets.
13. The Loadbus is powered by Generator Set source.
14. Normal Load Add sequence starts as described in *Load Add Sequence during Loss of Utility Source.*

15. Load Demand operates if enabled as described in *Load Demand*.

3.4.4 Test with Load Off (Auto – Open Transition)

1. The system test command is removed from the system.
2. The system follows sequence described in *Return of a Single Utility Source (Auto – Open Transition).*

3.4.5 Test with Load On (Auto – Soft Closed Transition)

The operator can make a selection for which Loadbus to be tested at the DMC System Control Screen. Following Test with Load sequence is applicable to either transfer pair when there is a single Loadbus test.

1. The system is commanded to enter into Test with Load.
2. The DMC sends a start signal to all the Generator Sets.
3. Minimum Capacity to Connect to Loadbus timer starts. (The Generator Sets start signal will be removed if the Minimum Capacity to Connect is not reached before the timer expires. Operator Intervention is required at this point.)
4. Generator Sets start automatically, independently, and accelerate to the rated voltage and frequency.
5. The first Generator Set closes to the bus as dictated by the First Start System.
6. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
7. A configurable Transfer Delay starts in the DMC when the Minimum Capacity to Connect to Loadbus is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
8. When the configurable Transfer Delay expires, the master synchronizer is enabled between the Generator Set Source and the Utility Source to synchronize the Generator Sets to the Utility Source.
9. The DMC verifies that Minimum Capacity to Connect to Loadbus is still true and the sync check conditions are met for the 52-GM breaker, the DMC commands the 52-GM breaker to close, and the 52-GM breaker closes.
10. Generator Sets start to ramp up.
11. When the load across the 52-UM breaker is below the Unload kW threshold (default 50kW, configurable), the DMC commands the 52-UM breaker to open, and the 52-UM breaker opens.
12. The Loadbus is powered by Generator Set source.
13. Load Demand operates if enabled as described in *Load Demand*.

3.4.6 Test with Load Off (Auto – Soft Closed Transition)

1. The system test command is removed from the system.
2. The system will follow sequence described in *Return of a Single Utility Source (Auto – Soft Closed Transition).*

3.4.7 Test with Load On (Auto – Open Transition)

The operator selects Loadbus 1 and Loadbus 2 at the DMC System Control Screen. The DMC will use the applicable time delays and other configurable settings defined for each transfer pair in the following sequence.

1. The system is commanded to enter into Test with Load.
2. The DMC sends a start signal to all the Generator Sets.
3. Minimum Capacity to Connect to Loadbus timers start (If the Minimum Capacity to Connect is not reached for Loadbus 1 and it is not reached for Loadbus 2 before the timer expires the start signal will be removed. Operator Intervention is required at this point.)
4. Generator Sets start automatically, independently, and accelerate to the rated voltage and frequency.
5. The first Generator Set closes to the bus as dictated by the First Start System.
6. A configurable Transfer Delay starts in the DMC when the Minimum Capacity to Connect to each Load Bus is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
7. When the configurable Transfer Delay expires for the first transfer pair, the DMC commands the 52-UM1 breaker to open, and the 52-UM1 breaker opens.
8. All the feeder breakers not assigned to Shed Level 0 are commanded to open on the Loadbus.
9. After the 52-UM1 breaker opens, a configurable Programmed Transition Delay for the first transfer pair starts in the DMC.
10. After the configurable Programmed Transition Delay expires, the DMC verifies that Minimum Capacity to Connect to Loadbus 1 is still true.
11. The DMC commands the 52-GM1 breaker to close, the 52-GM1 breaker closes.
12. The Loadbus 1 is powered by Generator Set source.
13. All the feeder breakers assigned to Load add Level 1 for that Loadbus 1 are commanded to close.
14. The DMC monitors completion status of the Transfer Delay for the second transfer pair that requires Generator service.
15. The DMC commands the 52-UM2 to open, the 52-UM2 breaker opens.
16. All the feeder breakers not assigned to Shed Level 0 are commanded to open on the Loadbus 2.
17. After the 52-UM2 breaker opens, a configurable Programmed Transition Delay for that transfer pair starts in the DMC.
18. After the configurable Programmed Transition Delay expires, the DMC verifies that Minimum Capacity to Connect to Loadbus 2 is still true.
19. The DMC commands the 52-GM2 breaker to close, the 52-GM2 breaker closes.
20. The Loadbus 2 is powered by Generator Set source.
21. Normal Load Add sequence starts as described in *Load Add Sequence during Loss of Utility Source.*
22. Load Demand operates if enabled as described in *Load Demand*.

3.4.8 Test with Load Off (Auto – Open Transition)

1. The system test command is removed from the system.
2. The system follows sequence described in *Return of both Utility Sources (Auto – Open Transition).*

3.4.9 Test with Load On (Auto – Soft Closed Transition)

The operator selects Loadbus 1 and Loadbus 2 at the DMC System Control Screen. The DMC will use the applicable time delays and other configurable settings defined for each transfer pair in the following sequence.

1. The system is commanded to enter into Test with Load.
2. The DMC sends a start signal to all the Generator Sets.
3. Minimum Capacity to Connect to Loadbus timers start (If the Minimum Capacity to Connect is not reached for Loadbus 1 and it is not reached for Loadbus 2 before the timer expires the start signal will be removed. Operator Intervention is required at this point.)
4. Generator Sets start automatically, independently, and accelerate to rated voltage and frequency.
5. The first Generator Set closes to the bus as dictated by the First Start System.
6. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
7. A configurable Transfer Delay starts in the DMC when the Minimum Capacity to Connect to each Load Bus is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
8. When the configurable Transfer Delay expires for the first transfer pair, the master synchronizer is enabled between the Generator Set Source and the Utility Source 1 to synchronize the Generator Sets to the Utility Source 1.
9. The DMC verifies that Minimum Capacity to Connect to Loadbus 1 is still true and the sync check conditions are met for the 52-GM1 breaker, the DMC commands the 52-GM1 breaker to close, and the 52-GM1 breaker closes.
10. Generator Sets start to ramp up.
11. When the load across the 52-UM1 breaker is below the Unload kW threshold (default 50kW, configurable), the DMC commands the 52-UM1 breaker to open, and the 52-UM1 breaker opens.
12. The DMC monitors completion status of the Transfer Delay for the second transfer pair that requires Generator service.
13. When the configurable Transfer Delay expires for the second transfer pair, the master synchronizer is enabled between the Generator Set Source and the Utility Source 2 to synchronize the Generator Sets to the Utility Source 2.
14. The DMC verifies that Minimum Capacity to Connect to Loadbus is still true and the sync check conditions are met for the 52-GM2 breaker, the DMC commands the 52-GM2 breaker to close, and the 52-GM2 breaker closes.
15. Generator Sets start to ramp up.
16. When the load across the 52-UM2 breaker is below the Unload kW threshold (default 50kW, configurable), the DMC commands the 52-UM2 breaker to open, and the 52-UM2 breaker

opens.

17. Normal Load Add sequence starts as described in ***Error! Reference source not found.***.
18. Load Demand operates if enabled as described in *Load Demand*.

3.4.10 Test with Load Off (Auto – Soft Closed Transition)

1. The system test command is removed from the system.
2. The system will follow sequence described in *Return of both Utility Sources (Auto – Soft Closed Transition).*

4 Normal Load Control

4.1 Load Control Levels

Normal load control uses two sets of levels for control. Each Loadbus has its own set of levels for control. These are the add levels which range from 0-8 and the shed levels which range from 0-7. A single load may only have 1 level for add and 1 level for shed assigned to it. It is possible that multiple loads may share the same level for either add or shed throughout the system.

Add levels are used to control the load stepping onto the Generator Sets while Generator Sets are connecting to the Loadbus. Level 1 is the first load to add. Level 2 is the second load to add, and so forth up to the total Load Add Levels assigned in the system.

Shed levels are used to handle removing load from the Loadbus if the DMC receives a Load Dump signal from the Generator Sets. Level 1 is the first load to shed. Level 2 is the second load to shed, and so forth up to the total load shed levels in the system. A shed level of 0 is used for a critical load that should never shed. Since a level 0 load never sheds, it cannot have an add level higher than 1, since it is assumed to be on the Loadbus once the Generator Sets connect.

Shed level assignment can be done automatically by the DMC based on the Load Add Level assignments or can be user defined. When user defined, the restrictions state above for shed level 0 still apply.

A level 0 add level assigned to a load is a load that is removed from the load add sequence. The load will neither add nor shed with the other levels in the system. A load assigned to an add level of 0 is forced to have a shed level of 0. This is useful for loads that are to be added as futures to the system.

4.2 Load Control Sizing

When sizing the system loads to Generator Sets, load(s) assigned to add level 1 should not exceed the kW capacity of the smallest Generator Set in the system. Loads assigned to add level 2 should not exceed the kW capacity of the smallest two Generator Sets in the system. This philosophy should continue for all Generator Sets in the system until the Required Online Capacity is reached. The size of the Generator Sets relative to the loads is important if the Generator Sets are not the same size throughout the system. Starting with the smallest Generator Set to size the loads takes into account the worst case sizing scenario.

4.3 Load Control Timing

The Loadbus has two delay timers for controlling the load. The Load Add Genbus delay is the minimum amount of time that must expire before adding the next Load Add Level. This ensures loads do not add rapidly should Generator Sets parallel with each other on the Loadbus quickly.

The Load Shed Delay is the time delay that must expire before shedding the next load shed level. This is to allow the system to stabilize before shedding load too rapidly and possibly dropping more load than is required to clear the Overload condition.

4.4 Load Add Sequence during Loss of Utility Source

1. Each load on Loadbus 1 and Loadbus 2 is assigned a Load Add Level.
2. When Min Capacity to Connect is reached and the 52-GM breaker is closed connecting the Generator Source to the Loadbus, all loads assigned to Load Add Level 1 should already be connected to the Loadbus but a level 1 load add command will still be issued.
3. When the second Generator Set connects to the Loadbus and the Load Add Genbus delay timer has expired, all loads assigned to Load Add Level 2 are commanded to add.
4. The Load Add Genbus Delay timer resets and starts timing for the next Load Add Level.
5. This sequence continues until the Required Online Capacity for the Loadbus is met or when all existing Generator Sets connect to the Loadbus. When this threshold is met, any remaining levels are added. The time in between adding these loads is set by the Load Add Genbus Delay.
6. In the event that the Required Online Capacity for the Loadbus is not met and not all existing Generator Sets connect to the Loadbus, the DMC only adds Load Add Levels equal to the number of Generator Sets online. Any further Load Add Levels need to be added by operator intervention using the control buttons from the DMC Load Control Screen. The operator is responsible for verifying enough capacity exists to add a specific level. Levels need not be added in order.
7. If both Loadbusses require Generator service, Normal Load Control on the connected Loadbus is paused until the second Loadbus reaches Min Capacity to Connect, initiates the transfer and closes its 52-GM breaker. All loads assigned to Load Add Level 1 should already be connected but a level 1 load add command will still be issued to the second Loadbus.
8. If the second Loadbus fails to connect for any reason, the Load Add pause on the first Loadbus will be released and the other Load Add Levels will be added per the sequence. Once Load Add Level 1 is added on the second Loadbus, the Load Add Genbus Delay timer starts timing. Additional Generator Sets may already be connected due to the Min Capacity to connect requirements but additional load add levels will always wait for the completion of the Load Add Genbus Delay.
9. When the second Generator Set connects to the Loadbus and the Load Add Genbus delay timer has expired, all loads assigned to Load Add Level 2 on both Loadbus 1 and Loadbus 2 are commanded to add.
10. This sequence continues until the Required Online Capacity for the Loadbus is met or when all existing Generator Sets connect to the Loadbus. When this threshold is met, any remaining levels are added. The time in between adding these loads is set by the Load Add Genbus Delay.
11. If an Overload condition occurs for any reason, the Load Add sequence will stop and the system starts the *Load Shed Sequence.*

4.5 Load Add Sequence during Return to Utility Source

1. Each load on Loadbus is assigned a Load Add Level.
2. All loads assigned to Load Add Level 1 should already be connected to the Loadbus but a level 1 load add command will still be issued.

3. The Load Add Utility Delay timer starts timing as soon as the 52-UM breaker closes.
4. When the Load Add Utility delay timer has expired, all loads assigned to Load Add Level 2 are commanded to add.
5. The Load Add Utility Delay timer resets and starts timing for the next Load Add Level.
6. This sequence continues until all Load Add Levels are commanded to add. The time in between adding these loads is set by the Load Add Utility Delay.

4.6 Load Shed Sequence

1. Each load is assigned a Load Shed Level.
2. One or more connected Generator Sets sends a Load Dump signal to the DMC. Refer to the *Definitions.*
3. Upon detection of an overload (Load Dump) signal from any Generator Set, the smallest non-zero load shed level that is supplied by the Generator Source is immediately turned on. Typically, this is load shed level 1. (An example of when this would not be shed level 1 is if the Load Add Sequence had not run to completion before the overload occurred or if no loads were ever assigned to Load Shed Level 1.)
4. The Load Shed Delay timer starts timing.
5. When the Load Shed Delay timer expires, the DMC continues to monitor the Load Dump signal. If still present, the next Load Shed Level that is supplied by the Generator Source is turned on. Typically this is Load Shed Level 2.
6. The Load Shed Delay timer resets and starts timing again for the next Load Shed Level.
7. This sequence continues until all Load Shed Levels that were connected to the Loadbus turn on (except for Load Shed Level 0) or until the DMC detects the Load Dump signal has been removed by the Generator Sets.
8. When the overload condition is no longer active, the operator may reset the overload alarm and restore Load Shed Levels from the DMC Load Control Screen. Restoration of Load Shed Levels need not occur in order.
9. Loads that have been shed cannot be restored until the overload alarm is cleared.
10. As long as the system is on Generator Sets, there is no automatic restore for levels that have been shed. They must be manually restored by the operator.
11. If an overload condition happens while the system is on Generator Set Source while in the Test with Load mode in Auto – Open Transition, as long as the Authorized return to Utility is not selected the test will be immediately terminated and the system is retransferred to the Utility Source with no load sheds occurring. If Authorized Return to Utility is selected the system will stay in Test with Load and the normal shed sequence will occur.
12. If an overload condition happens while the system is on Generator Set Source while in the Test with Load mode in Auto – Soft Closed Transition, as long as the Authorized return to Utility is not selected the test will be immediately terminated, a retransfer to the Utility Source will be initiated and the normal shed sequence will occur. If Authorized Return to Utility is selected the system will stay in Test with Load and the normal shed sequence will occur.
13. If the system is retransferred to the Utility source while there are still shed levels active, the sheds would be automatically cleared and the load levels restored to the Utility source.
14. In the event that a restored level causes an overload condition, restoration of levels is stopped and the Load Shed Sequence starts again.

4.7 Quick Shed (Selectable at the HMI)

The Quick Shed feature is used when the failure of a Generator Set will have a significant effect of the stability of the Generator Set supply to the load. If Quick Shed is enabled and a Generator Set shutdown is detected, all Load Shed Levels are shed except for Load Shed Level 0. The Load Add Sequence is then re-started and Load Add Levels are added on a timed basis until the number of Generator Sets connected to the Loadbus equals the Load Add Level. If the Required Online Capacity for the Loadbus is again met even with a Generator Set shutdown, loads will be added on a timed basis until all levels are added.

4.8 Open Transition Utility Transfer Load Shed (Selectable at the HMI)

When transferring to a Utility Source, the DMC allows the capability for feeder breakers to remain closed during the open transition transfer. This is selectable from the DMC Setup Screen. This will block load the Utility Source with the facility load as soon as the Utility circuit breaker closes. This will reduce the number of cycles on the feeder breakers and reduce the time load will be unpowered during the transition to the Utility Source.

5 Load Demand

The Load Demand feature is used to match generating capacity to the load in order to optimize fuel efficiency and prolong Generator Set life while maintaining the right amount of reserve capacity for the customer's application. The DMC offers the flexibility of deciding whether Generator Set operating percentage or facility load steps should be used to determine the number of Generator Sets to run for a specific load. The desired Load Demand Sequence and Set points must be set up at the DMC Load Demand Screen. After all the parameters have been set up, the system will follow the desired Load Demand sequence. Detailed description of all the set points is available *Load Demand Set Points.*

The Load Demand sequence will be automatically adjusted if a Generator Set warning alarm occurs. The Generator Set that has a warning fault will be moved to the lowest priority Generator Set in the sequence. If not all Generator Sets are required to supply the load the Generator Set experiencing the fault will be the first to shut down, reducing the risk that the warning condition could develop into a more serious fault. This takes priority over all other sequence settings methods.

There are a number of conditions that would inhibit or cancel the Load Demand function. All Load Demand stop commands will be removed. They are as follows:

1.) There is an active Overload condition.
2.) The system is set to the Manual Mode from the DMC System Control Screen. (There is no Generator Set restart with this condition until the system is returned to Auto – Open Transition or Auto – Soft Closed Transition).
3.) The Genbus metering fails.
4.) The Generator Set I/O Island fails.
5.) The Load Demand feature is disabled from the DMC Load Demand Screen.

Load Demand Modes are:

5.1 Run Hours Monitoring

The Load Demand sequence can be set to change based on the engine run hours of the Generator Sets in the system. The Generator Sets with the lowest run hours will have the highest priority in the Load Demand sequence and will accumulate more run hours than the lower priority

Generator Sets. The amount of difference between the engine hours before the Load Demand sequence is adjustable from 1 to 500 hours.

5.2 Auto Rotate

The Load Demand sequence can be set to change every time the Load Demand function is activated. The lead unit will become the lowest priority Generator Set and all other Generator Sets in the system will increase in priority by one level.

5.3 User Defined

The Load Demand sequence can be set up by the operator. In this method the only change to the sequence will be by an operator or to increase the system reliability in the case of a Generator Set warning.

6 Authorized Return to Utility Mode

This feature can be used to inhibit the automatic retransfer back to the Utility Source until it is manually initiated by an operator. This is selectable from the DMC Setup Screen.

7 Generator Set Manual Operation

When the Manual Mode is selected at the HMI, no automatic operations will be performed by the DMC. All Generator Set start/stop and any breaker open/close must be initiated by an operator.

7.1 Manual Operation from the HMI

1. The operator initiates this mode by selecting Transition Type of Manual from the DMC System Control Screen.
2. This mode allows the operator to start/stop each Generator Set and open/close each Generator Set Breaker from DMC Generator Summary Screen.
3. The operator exits this mode by selecting a Transition Type of either Auto – Open Transition or Auto – Soft Closed Transition from the DMC System Control Screen.

7.2 Main Breakers Manual Operation from the HMI (Optional)

1. Manual Control of the Main Breakers (52-UM and 52-GM) is an optional feature that must be specified at the time of order.
2. The operator initiates this mode by selecting Transition Type of Manual from the DMC System Control Screen.
3. This mode also allows the operator to open/close Utility Main 52-UM breakers, and Generator Main 52-GM breakers by touching their icons on the DMC One line Screen.
4. 52-UM and 52-GM breakers may not be allowed to be manually closed from the HMI under certain conditions. In Manual mode, the Loadbus must be confirmed dead before the PLC will allow the closing of the main breakers (if the state of the Loadbus is unknown or live, PLC will not allow the operator to close the main breakers.)

7.3 Manual Operation from the PowerCommand Control (PCC)

This mode can be used if the DMC fails and it becomes necessary to start the Generator Sets and connect them to the Loadbus.

1. Place the mode control switch for the transfer pair(s) in Manual.
2. Place the Generator Set in manual from the local Generator Set PCC.
3. Start each Generator Set manually and close its Generator Set Breaker to a dead or live bus from the PCC. Refer to the specific Generator Set manual to perform this function.
4. When Generator Sets are connected to the Genbus, follow your facility safety procedures to manually add additional loads if sufficient capacity exists.
5. Control the 52-UM and 52-GM breakers with their individual breaker control switches on the front of the switchgear.
6. 52-UM and 52-GM breakers are electrically interlocked to prevent any manual closed transition operation.
7. Return the Generator Sets to standby mode by disconnecting facility loads per your facility procedures. Open each Generator Set Breaker and shut down each Generator Set from the respective PCC.
8. Switch each Generator Set control switch from Manual to Auto mode at local Generator Set PCC.
9. The mode control switch of the transfer pair should be returned to Auto mode after 52-UM and 52-GM breakers are set to their normal standby conditions.

8 Load Demand Set Points

The Set Points used depend on the Load Demand Sequence selected.

The DMC automatically shuts down and restarts Generator Sets in an order determined by the Load Demand Sequence selected. Generator Set faults may cause the DMC to automatically reorder the sequence. The sequence is shown in alphabetical order such as Lead (A), B, and so on, depending on the total number of Generator Sets in the system.

The shutdown and restart sequence determines the order in which Generator Sets are shut down and restarted. The sequence is defined in the order Lead (A) unit, B unit, C unit, D unit, etc. Each letter is assigned a Generator Set number. Each Generator Set in the sequence can only appear once. All Generator Sets in the sequence must be part of the system (does not include future Generator Sets).The shutdown order is executed in reverse alphabetical order. The restart order is executed in alphabetical order. The Lead unit is the highest priority and will never be shut down.

8.1 Percent or Absolute kW

The Shutdown and Restart set points can use %kW or Absolute kW to determine the thresholds for starting and stopping the Generator Sets. The default unit is %kW. The %kW method is less efficient the larger the site load is as the reserve capacity is percentage rather than a fixed amount. It is recommended that the Absolute kW value be used under the following conditions.

- More than 4 Generator Sets in the system.
- The system fuel efficiency has high importance.
- The system redundancy, such as N+1 for the Generator Sets has high importance.

In all cases if Absolute kW is used, the load profile of the site must be understood well enough to determine spinning reserve requirements.

8.1.1 Shutdown %kW (Percent kW)

The percentage of the load that will be carried by the remaining Generator Sets once a Generator Set is shut down by load demand. The actual load on the Generator Sets must be less than this value prior to a Generator Set shutdown. The shutdown %kW must be at least 5 percent smaller than the restart %kW.

8.1.2 Restart %kW (Percent kW)

The percentage of online load with respect to the online Generator Set capacity that must be exceeded to restart the next Generator Set in the Load Demand sequence.

8.1.3 Shutdown kW (Absolute kW)

Shutdown kW must be set to a number greater than Restart kW. It should be set based upon how rapidly and how much load can decrease. If set too low, Generator Sets will cycle on and off too frequently. If set too high, system efficiently will decrease since more Generator Sets will be running than needed. The shutdown capacity is the amount of reserve capacity that will be left when the lowest priority Generator Set shuts down. This should be at least 5% of the Generator capacity more than the restart kW, or more if the loads that cycle repetitively are larger than this value. For convenience the actual pickup and dropout point for each Generator Set in the system can be viewed once the set points have been entered.

8.1.4 Restart kW (Absolute kW)

Restart kW sets the minimum amount of spare online capacity that the system will always try to maintain, i.e., the spinning reserve amount. This settings depends on system requirements. If you want to maintain additional generation to cover for a failure of Generator Sets, setting the Restart kW greater than the size of one Generator Set will ensure that you will still have some reserve capacity after the Generator Set goes offline. If fuel economy is more important, the restart kW should be the largest amount of load increase that can happen before the system is able to add another Generator Set.

8.2 Initial Delay

The time that the DMC waits after load demand is enabled and all conditions for Load Demand have been met before Load Demand becomes active.

8.3 Shutdown Delay

The time the system waits before shutting down a Generator Set if the facility load is sufficiently low. The shutdown time delay is used to place the applicable number of Generator Sets in Load Demand stop for the load required by the Generator Set bus. When Load Demand is enabled, the system calculates the Generator Sets that may be shut down. Any Generator Set whose Shutdown kW is less than the load kW will initiate the shutdown timer. If more than one Generator Set has a Shutdown kW that is less than the load kW, the shutdown timers will begin timing 5 seconds apart, so that the Generator Sets will be stopped sequentially every 5 seconds.

8.4 Restart Delay

The restart delay is the time required for the Generator Set bus to be at or greater than the restart capacity. This delay helps prevent a Generator Set from restarting unnecessarily due to load transients.

8.5 Run Hour Differential (Run Hours)

The minimum difference of run hours between the Generator Sets for the Run Hours Load Demand Sequence.

8.6 Spare Capacity Pick Up (Selectable at the HMI)

The system has a remote input contact that allows the Load Demand function to respond to large load steps. When the input is on, the Load Demand system adds the spare capacity pick up kW to the actual load and starts enough Generator Sets to make sure that the Generator Sets can supply the additional load. This feature is useful for facilities that have large loads that are periodically added to the system. The Load Demand set points are optimized to reduce fuel consumption of the Generator Sets while still providing a means to start large loads.

9 Failure Modes

9.1 Generator Set Failures

9.1.1 Generator Set Fail to Start

If a unit fails to start after the over crank or fail to crank time delay (time set in the PCC) expires, the unit shuts down and an alarm sounds on the DMC.

If any Generator (GA1 or GA2) on the A side are to shut down then a signal is to be sent to the DDC (A/B/C) Mech panel so that all Supply Fans A are to stop and all respective Dampers are to close.

If any Generator (GB1 or GB2) on the B side are to shut down then a signal is to be sent to the DDC (A/B/C) Mech panel so that all Supply Fans B are to stop and respective Dampers are to close.

9.1.2 Generator Set Fail to Synchronize

If a unit fails to synchronize after a preset time delay (time set in the PCC), an alarm sounds on the DMC and the unit continues attempting to synchronize until signaled to stop by an operator either on the PCC or from the DMC Generator Set Summary Screen.

9.1.3 Generator Set Fail to Come Online

If an available Generator Set fails to come online after the time delay (time set in the DMC control) expires, an alarm sounds on the DMC.

9.1.4 Generator Set Breaker Fail to Close

If a Generator Set breaker fails to close, an alarm sounds on the DMC and the unit may or may not shutdown depending on how it is configured in the PCC. The operator resets the alarm at the PCC and the DMC.

9.1.5 Generator Set Breaker Fail to Open

If a Generator Set breaker fails to open, an alarm sounds on the DMC and the unit continues to run with fail to open warning. Once the breaker is open, operator resets the alarm at the PCC and the DMC.

9.1.6 Generator Set Breaker Fail to Open on Shutdown

If a Generator Set breaker fails to open and the Generator Set shuts down, an alarm sounds on the DMC. The other Generator Sets are inhibited and start signals are removed to isolate the failed Generator Set. The failed Generator Set must be disconnected from the bus to reset the alarm at the DMC.

9.2 52-UM Breaker Failures (Auto – Open Transition)

9.2.1 52-UM Breaker Fail To Open during Loss of Utility Source

The following sequence is applicable to either transfer pair.

1. The DMC receives a loss of Utility Source signal from the device monitoring the Utility Source.
2. A configurable Utility Fail Delay within the DMC times and expires.
3. The DMC sends a start signal to all the Generator Sets.
4. Minimum Capacity to Connect to Loadbus timer starts.
5. Generator Sets start automatically, independently, and accelerate to the rated voltage and frequency.
6. The first Generator Set closes to the bus as dictated by the First Start System.
7. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
8. A configurable Transfer Delay starts in the DMC when the Minimum Genbus Capacity is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
9. When the configurable Transfer Delay expires, the DMC commands the 52-UM breaker to open but *the 52-UM breaker fails to open.*
10. “52-UM Fail to Open” alarm is registered on the DMC.
11. The DMC removes the 52-UM breaker open signal.
12. If the other transfer pair requires Generator service, the system will continue the transfer to the Generator Source on the other Loadbus. The start signal will be turned off if there is no demand for Generator service.

9.2.2 52-UM Breaker Fail To Open Reset

1. The operator clears the fault on the 52-UM breaker and resets the alarm on the DMC.
2. If the Utility Fail Signal is still present, the system will follow sequence described in *Loss of a Single Utility Source (Auto – Open or Auto – Soft Closed Transition).*

9.2.3 52-UM Breaker Fail To Open during Test with Load

The following sequence is applicable to either transfer pair.

1. The system is commanded to enter into Test with Load.
2. The DMC sends a start signal to all the Generator Sets.
3. Minimum Capacity to Connect to Loadbus timer starts.
4. Generator Sets start automatically, independently, and accelerate to the rated voltage and

frequency.

5. The first Generator Set closes to the bus as dictated by the First Start System.
6. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
7. A configurable Transfer Delay starts in the DMC when the Minimum Capacity to Connect to Loadbus is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
8. When the configurable Transfer Delay expires, the DMC commands the 52-UM breaker to open but the *52-UM breaker fails to open.*
9. “52-UM Fail to Open” alarm is registered on the DMC.
10. The DMC removes the 52-UM breaker open signal.
11. The system is removed from Test with Load.
13. If the other transfer pair requires Generator service, the system will continue the transfer to the Generator Source on the other Loadbus. The start signal will be turned off if there is no demand for Generator service.

9.2.4 52-UM Breaker Fail To Open Reset

1. The operator clears the fault on the 52-UM breaker and resets the alarm on the DMC.
2. The system is in *Normal Standby Conditions* and will not reenter test automatically.

9.2.5 52-UM Breaker Fail To Close on Retransfer to Utility Source

The following sequence is applicable to either transfer pair when retransferring from Utility Source failure or Test with Load command is removed.

1. The DMC detects the removal of the loss of Utility Source signal from the device monitoring the Utility Source or Test with Load command is removed from the system.
2. A configurable Retransfer Delay starts in the DMC.
3. When the configurable Retransfer Delay expires, the DMC commands the 52-GM breaker to open, and the 52-GM breaker opens.
4. All the feeder breakers not assigned to Shed Level 0 are commanded to open.
5. After the 52-GM breaker opens, a configurable Programmed Transition Delay starts in the DMC.
6. When the configurable Programmed Transition Delay expires, the DMC commands the 52-UM breaker to close but the *52-UM breaker fails to close*.
7. “52-UM Fail to Close” alarm is registered on DMC.
8. The DMC removes the 52-UM breaker close signal.
9. The DMC commands the 52-GM breaker to close, and the 52-GM breaker closes.
10. Normal Load Add sequence starts as described *in Load Add Sequence during Loss of Utility Source.*
11. Load Demand operates if enabled as described in *Load Demand*.
12. If the other transfer pair is ready to be retransferred to the Utility Source, the system will continue the retransfer to the Utility Source on the other Loadbus.

9.2.6 52-UM Breaker Fail To Close Reset

1. The operator clears the fault on the 52-UM breaker and resets the alarm on the DMC.
2. If the Utility Source is available, the system will follow applicable Utility retransfer sequence.
3. If the Utility Source is not available, the facility load remains powered by the Generator Set source.

9.3 52-GM Breaker Failures (Auto - Open Transition)

9.3.1 52-GM Breaker Fail To Open on Retransfer to Utility Source

The following sequence is applicable to either transfer pair when retransferring from Utility Source failure or Test with Load command is removed.

1. The system is powered by Generator Set Source either because of Loss of Utility Source or System in Test with Load.
2. The system is removed from Test with Load or Utility Source Returns.
3. A configurable Retransfer delay starts in the DMC.
4. When the Retransfer delay expires, the DMC commands the 52-GM breaker to open but *the 52-GM breaker fails to open.*
5. “52-GM Fail to Open” alarm is registered on the DMC.
6. The DMC removes the 52-GM breaker open signal.
7. Generator Sets continue to run to power the Loadbus. If the other transfer pair is ready to be retransferred to the Utility Source, the system will continue the retransfer to the Utility Source on the other Loadbus.

9.3.2 52-GM Breaker Fail To Open Reset

1. The operator clears the fault on the 52-GM breaker and resets the alarm on the DMC.
2. If the Utility Source is available, the system will follow sequence described in *Return of a Single Utility Source (Auto – Open Transition).*
3. If the Utility Source is not available, the facility remains powered by the Generator Set source.

9.3.3 52-GM Breaker Fail To Close during Loss of Utility Source

The following sequence is applicable to either transfer pair.

1. The DMC receives a loss of Normal Source signal from the device monitoring the Utility Source.
2. A configurable Utility Fail Delay within the DMC times and expires.
3. The DMC sends a start signal to all the Generator Sets.
4. Minimum Capacity to Connect to Loadbus timer starts.
5. Generator Sets start automatically, independently, and accelerate to the rated voltage and frequency.
6. The first Generator Set closes to the bus as dictated by the First Start System.
7. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their

PowerCommand Controls.

8. A configurable Transfer Delay starts in the DMC when the Minimum Genbus Capacity is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
9. When the configurable Transfer Delay expires, the DMC commands the 52-UM breaker to open, and the 52-UM breaker opens.
10. All the feeder breakers not assigned to Shed Level 0 are commanded to open.
11. After the 52-UM breaker opens, a configurable Programmed Transition Delay starts in the DMC.
12. After the configurable Programmed Transition Delay expires, the DMC verifies that Minimum capacity to connect to Loadbus is true.
13. The DMC commands the 52-GM breaker to close but the *52-GM breaker fails to close.*
14. "52-GM Fail to Close" alarm is registered on the DMC.
15. The DMC removes the 52-GM breaker close signal.
16. The facility load remains unpowered.
17. If the Utility Source returns, the 52-UM breaker will close.
18. If the other transfer pair requires Generator service, the system will continue the transfer to the Generator Source on the other Loadbus. The start signal will be turned off if there is no demand for Generator Service.

9.3.4 52-GM Breaker Fail To Close Reset

1. The operator clears the fault on the 52-GM breaker and resets the alarm on the DMC.
2. If the Utility Source is not available, the system will follow sequence described in *Loss of a Single Utility Source (Auto – Open or Auto – Soft Closed Transition).*
3. If the Utility Source is available, the system will follow sequence described in *Return of a Single Utility Source (Auto – Open Transition).*

9.3.5 52-GM Breaker Fail To Close during Test with Load On

The following sequence is applicable to either transfer pair.

1. The system is commanded to enter into Test with Load.
2. The DMC sends a start signal to all the Generator Sets.
3. Minimum Capacity to Connect to Loadbus timer starts.
4. Generator Sets start automatically, independently, and accelerate to the rated voltage and frequency.
5. The first Generator Set closes to the bus as dictated by the First Start System.
6. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
7. A configurable Transfer Delay starts in the DMC when the Minimum Capacity to Connect to Loadbus is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
8. When the configurable Transfer Delay expires, the DMC commands the 52-UM breaker to

open, and the 52-UM breaker opens.

9. All the feeder breakers not assigned to Shed Level 0 are commanded to open.
10. After the 52-UM breaker opens, a configurable Programmed Transition Delay starts in the DMC.
11. After the configurable Programmed Transition Delay expires, the DMC verifies that Minimum Capacity to Connect to Loadbus is true.
12. The DMC commands the 52-GM breaker to close but the *52-GM breaker fails to close.*
13. "52-GM Fail to Close" alarm is registered on the DMC.
14. The DMC removes the 52-GM breaker close signal.
15. The system is removed from Test with Load.
16. The DMC commands the 52-UM breaker to close, and the 52-UM breaker closes.
17. Normal Load Add sequence starts as described in *Load Add Sequence during Return to Utility Source.*
18. The Loadbus is powered by the Utility Source.
19. If the other transfer pair requires Generator service, the system will continue the transfer to the Generator Source on the other Loadbus. The start signal will be turned off if there is no demand for Generator service.

9.3.6 52-GM Breaker Fail To Close Reset

1. The operator clears the fault on the 52-GM breaker and resets the alarm on the DMC.
2. System is in *Normal Standby Conditions* and will not reenter the Test with Load automatically.

9.4 52-UM Breaker Failure (Auto - Soft Closed Transition)

9.4.1 52-UM Breaker Fail To Open during Loss of Utility Source

1. The system will follow sequence described in Auto – Open Transition *52-UM Breaker Fail To Open during Loss of Utility Source.*

9.4.2 52-UM Breaker Fail To Open Reset

1. The operator clears the fault on the 52-UM breaker and resets the alarm on the DMC.
2. If the Utility Fail Signal is still present, the system will follow sequence described in *Loss of a Single Utility Source (Auto – Open or Auto – Soft Closed Transition).*

9.4.3 52-UM Breaker Fail To Open during Test with Load

The following sequence is applicable to either transfer pair.

1. The system is commanded to enter into Test with Load.
2. The DMC sends a start signal to all the Generator Sets.
3. Minimum Capacity to Connect to Loadbus timer starts.
4. Generator Sets start automatically, independently, and accelerate to the rated voltage and frequency.
5. The first Generator Set closes to the bus as dictated by the First Start System.

6. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
7. A configurable Transfer Delay starts in the DMC when the Minimum Genbus Capacity is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
8. When the Configurable Transfer Delay expires, Synchronizer is enabled between the Utility Source and the Genbus to synchronize the Generator Sets to the Utility Source.
9. The DMC verifies that Minimum capacity to connect to Loadbus is true and the DMC commands the 52-GM breaker to close, the 52-GM breaker closes and Minimum capacity to connect to Loadbus timer stops and resets.
10. Generator Sets start to ramp up.
11. When the load across the 52-UM breaker is below the Unload kW threshold (default 50kW, configurable), the DMC commands the 52-UM breaker to open but the *52-UM breaker fails to open.*
12. “52-UM Fail to Open” alarm is registered on DMC.
13. The system is removed from Test with Load.
14. Generator Sets ramp down.
15. When the load across the 52-GM breaker is below the Unload kW threshold (default 50kW, configurable), the DMC commands the 52-GM breaker to open, and the 52-GM breaker opens.
16. If the other transfer pair requires Generator service, the system will continue the transfer to the Generator Source on the other Loadbus. The start signal will be turned off if there is no demand for Generator service.

9.4.4 52-UM Breaker Fail To Open Reset

1. The operator clears the fault on the 52-UM breaker and resets the alarm on the DMC.
2. The system is in *Normal Standby Conditions* and will not reenter Test with Load automatically.

9.4.5 52-UM Breaker Fail To Close on Retransfer to Utility Source

The following sequence is applicable to either transfer pair when retransferring from Utility Source failure or Test with Load command is removed.

1. The system is powered by Generator Set Source either because of Loss of Utility Source or System in Test with Load.
2. The system is removed from Test with Load or Utility Source Returns.
3. When the configurable Retransfer Delay expires, Synchronizer is enabled between the Utility Source and the Genbus to synchronize the Generator Sets to the Utility Source.
4. Once the Generator Sets synchronize to the bus and the sync check conditions are met for the 52-UM breaker, the DMC commands the 52-UM breaker to close but the *52-UM breaker fails to close.*
5. “52-UM Fail to Close” alarm is registered on DMC.
6. The DMC removes the 52-UM breaker close signal.
7. The system responds as Utility Failure sequence described in *Loss of a Single Utility Source*

(Auto – Open or Auto – Soft Closed Transition).

8. If the other transfer pair is ready to be retransferred to the Utility Source, the system will continue the retransfer to the Utility Source on the other Loadbus.

9.4.6 52-UM Breaker Fail To Close Reset

1. The operator clears the fault on the 52-UM breaker and resets the alarm on the DMC.
2. If the Utility Source is available, the system will follow sequence described in *Return of a Single Utility Source (Auto – Soft Closed Transition).*

9.4.7 Fail to Sync on Return of Utility Source or Test with Load Off

The following sequence is applicable to either transfer pair when retransferring from Utility Source failure or Test with Load command is removed.

1. The DMC detects the removal of the loss of Utility Source signal from the device monitoring the Utility Source or Test with Load command is removed.
2. A configurable Retransfer Delay starts in the DMC.
3. When the configurable Retransfer Delay expires, the master synchronizer is enabled between the Utility Source and the Genbus to synchronize the Generator Sets to the Utility Source.
4. If the Fail to Sync time delay expires before the sources are brought into sync the “Fail to Sync” alarm is registered on the DMC.
5. The synchronizer remains active attempting to synchronize the Generator Set source to the Utility Source. The synchronizer will be disabled if the other transfer pair is ready to be retransferred to Utility Source. Once the other transfer pair has successfully retransferred or failed to sync, the synchronizer will be enabled again.
6. The loads will continue to be carried by the Generator Set source until the sources come into sync and the transfer is completed or until the operator intervenes.
7. The operator can put the system in Auto – Open Transition mode and resets the alarm on the DMC and then the system will follow sequence described in *Return of a Single Utility Source (Auto – Open Transition).*

9.4.8 Fail to Sync while entering Test with Load The following sequence is applicable to either transfer pair.

1. The system is commanded to enter into Test with Load.
2. The DMC sends a start signal to all the Generator Sets.
3. Minimum Capacity to Connect to Loadbus timer starts.
4. Generator Sets start automatically, independently, and accelerate to the rated voltage and frequency.
5. The first Generator Set closes to the bus as dictated by the First Start System.
6. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
7. A configurable Transfer Delay starts in the DMC when; for Test with Load the Minimum Genbus Capacity is reached, (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing).

8. When the Configurable Transfer Delay expires, the master synchronizer is enabled between the Utility Source and the Genbus to synchronize the Generator Sets to the Utility Source.
9. If the Fail to Sync time delay expires before the sources are brought into sync the “Fail to Sync” alarm is registered on the DMC.
10. The system is removed from Test with Load.
11. If the other transfer pair requires Generator service, the system will continue the transfer to the Generator Source on the other Loadbus. The start signal will be turned off if there is no demand for Generator service.

9.5 52-GM Breaker Failures (Auto - Soft Closed Transition)

9.5.1 52-GM Breaker Fail To Open during Retransfer to Utility Source

The following sequence is applicable to either transfer pair.

1. The system is powered by Generator Set Source either because of Loss of Utility Source or system is in Test with Load.
2. The system is removed from Test with Load or Utility Source Returns.
3. A configurable Retransfer delay starts in the DMC.
4. When the configurable Retransfer Delay expires, Synchronizer is enabled between the Utility Source and the Genbus to synchronize the Generator Sets to the Utility Source.
5. Once the Generator Sets synchronize to the bus and the sync check conditions are met for the 52-UM breaker, the DMC commands the 52-UM breaker to close, and the 52-UM breaker closes.
6. Generator Sets start to ramp down.
7. When the load across the 52-GM breaker is below the Unload kW threshold (default 50kW, configurable), the DMC commands the 52-GM breaker to open but the *52-GM breaker fails to open.*
8. “52-GM Fail to Open” alarm is registered on the DMC.
9. The DMC removes the 52-GM breaker open signal.
10. Generator Sets continue to run to power the Loadbus.
11. The DMC commands the 52-UM breaker to open, and the 52-UM breaker opens.
12. Generator Sets are block loaded and supply power to the load.
13. If the other transfer pair is ready to be retransferred to the Utility Source, the system will continue the retransfer to the Utility Source on the other Loadbus.

9.5.2 52-GM Breaker Fail To Open Reset

1. The operator clears the fault on the 52-GM breaker and resets the alarm on the DMC.
2. If the Utility Source is available, the system will follow sequence described in *Return of a Single Utility Source (Auto – Soft Closed Transition).*

9.5.3 52-GM Breaker Fail To Close during Test with Load On

The following sequence is applicable to either transfer pair.

1. The system is commanded to enter into Test with Load.
2. The DMC sends a start signal to all the Generator Sets.
3. Minimum Capacity to Connect to Loadbus timer starts.
4. Generator Sets start automatically, independently, and accelerate to the rated voltage and frequency.
5. The first Generator Set closes to the bus as dictated by the First Start System.
6. The remaining Generator Sets synchronize to the Genbus and close their respective Generator Set breakers when synchronization conditions are met within their PowerCommand Controls.
7. A configurable Transfer Delay starts in the DMC when the Minimum Capacity to Connect to Loadbus is reached. (Configurable Transfer Delay would stop and reset should the capacity drop while the configurable Transfer Delay is timing.)
8. When the configurable Transfer Delay expires, the master synchronizer is enabled between the Generator Set Source and the Utility Source to synchronize the Generator Sets to the Utility Source.
9. The DMC verifies that Minimum Capacity to Connect to Loadbus is still true and the sync check conditions are met for the 52-GM breaker, the DMC commands the 52-GM breaker to close but the *52-GM breaker fails to close.*
10. “52-GM Fail to close” alarm is registered on the DMC.
11. The DMC removes the 52-GM breaker close signal.
12. The system is removed from Test with Load.
13. The facility load remains powered by the Utility Source.
14. If the other transfer pair requires Generator service, the system will continue the transfer to the Generator Source on the other Loadbus. The start signal will be turned off if there is no demand for Generator service.

9.5.4 52-GM Breaker Fail To Close Reset

1. The operator clears the fault on the 52-GM Breaker and resets the alarm on the DMC.
2. The system is in *Normal Standby Conditions* and will not reenter Test with Load automatically.

9.6 52-UM Breaker Lockout Failures

9.6.1 52-UM Breaker Lockout during Normal Standby Conditions

The system will follow the same sequence if the Lockout failure happens on either or both of the transfer pairs.

1. The system is in *Normal Standby conditions.*
2. The protective relay on the 52-UM breaker detects a Lockout condition.
3. The protective relay direct trips and locks out the 52-UM breaker.
4. “52-UM Lockout Trip” alarm is registered on the DMC.
5. No further action is taken. The DMC will not close a source to the Loadbus until the lockout relay is reset.

9.6.2 52-UM Breaker Lockout Reset

1. The operator resets the lockout relay on the 52-UM breaker and resets the alarm on the DMC.
2. If the Utility Source is available, the 52-UM breaker closes if no other source is online.
3. If the Utility Source is not available, the system will follow applicable Utility failure sequence.

9.6.3 52-UM Breaker Lockout during Test without Load

The system will follow the same sequence if the Lockout failure happens on either or both of the transfer pairs.

1. The system is in Test without Load.
2. The protective relay on the 52-UM breaker detects a Lockout condition.
3. The protective relay direct trips and locks out the 52-UM breaker.
4. “52-UM Lockout Trip” alarm is registered on the DMC.
5. Generator Sets continue to run unaffected in the Test without Load.
6. The operator may exit Test without Load at any time but once the Off mode is selected, the Test without Load is inhibited.

9.6.4 52-UM Breaker Lockout Reset

1. The operator resets the lockout relay on the 52-UM breaker and resets the alarm on the DMC.
2. If the Utility Source is available, 52-UM breaker closes if no other source is online.
3. If the Utility Source is not available, the system will follow applicable Utility failure sequence.

9.6.5 52-UM Breaker Lockout during Test with Load while Sources are in Parallel

This sequence is applicable to either transfer pair.

1. The system is in Test with Load and both sources are connected.
2. The protective relay on the 52-UM breaker detects a Lockout condition.
3. The protective relay direct trips and locks out the 52-UM breaker.
4. “52-UM Lockout Trip” alarm is registered on the DMC.
5. The system is removed from Test with Load.
6. Generator Sets continue to run and carry the load.
7. If the other transfer pair requires Generator service, the system will continue the transfer to the Generator Source on the other Loadbus.

9.6.6 52-UM Breaker Lockout Reset

1. The operator resets the lockout relay on the 52-UM breaker and resets the alarm on the DMC.
2. If the Utility Source is available, the system will follow applicable Utility return sequence.
3. If the Utility Source is not available, the system will follow applicable Utility failure sequence.

9.7 52-UM Breaker Protective Relay Failures

If the DMC detects a Protective Relay Failure on the 52-UM breaker, the DMC can no longer determine the state of the Utility Source and the 52-UM breaker does not have the adequate protection. The DMC will transfer the facility load to the most reliable protected source. The DMC will not close the 52-UM breaker if it has the Protective Relay Failure active.

9.7.1 52-UM Breaker Protective Relay Failure during Normal Standby Conditions

The system will follow the same sequence if the Protective Relay failure happens on either or both of the transfer pairs.

1. The system is in *Normal Standby Conditions.*
2. The DMC receives the Protective Relay Failure signal from the 52-UM breaker.
3. “52-UM Protective Relay Failure” alarm is registered on the DMC.
4. The system will follow applicable Utility Failure sequence.

9.7.2 52-UM Breaker Protective Relay Failure Reset

1. The fault condition is cleared on the relay.
2. The operator resets the Protective Relay Failure alarm on the DMC.
3. If the Utility Source is available, the system will follow applicable Utility Return sequence based on active transition type.
4. If the Utility Source is not available, the active sequence continues.

9.7.3 52-UM Breaker Protective Relay Failure during Utility Source Failure

The system will follow the same sequence if the Protective Relay failure happens on either or both of the transfer pairs.

1. The system is powered by Generator Set Source because of Loss of Utility Source.
2. The DMC receives the Protective Relay Failure signal from the 52-UM breaker.
3. “52-UM Protective Relay Failure” alarm is registered on the DMC.
4. The active Utility Failure sequence continues unaffected by the Protective Relay Failure.

9.7.4 52-UM Breaker Protective Relay Failure Reset

1. The fault condition is cleared on the relay.
2. The operator resets the Protective Relay Failure alarm on the DMC.
3. If the Utility Source is available, the system will follow applicable Utility retransfer sequence based on active transition type.
4. If the Utility Source is not available, the active sequence continues.

9.7.5 52-UM Breaker Protective Relay Failure during Test without Load

The system will follow the same sequence if the Protective Relay failure happens on either or both of the transfer pairs.

1. The system is in Test without Load.
2. The DMC receives the Protective Relay Failure signal from the 52-UM breaker.
3. “52-UM Protective Relay Failure” alarm is registered on the DMC.
4. The system is removed from Test without Load.
5. The system will follow applicable Utility Failure sequence.

9.7.6 52-UM Breaker Protective Relay Failure Reset

1. The fault condition is cleared on the relay.
2. The operator resets the Protective Relay Failure alarm on the DMC.
3. If the Utility Source is available, the system will follow applicable Utility Return sequence based on active transition type.
4. If the Utility Source is not available, the active sequence continues.

9.7.7 52-UM Breaker Protective Relay Failure during Test with Load

The system will follow the same sequence if the Protective Relay failure happens on either or both of the transfer pairs.

1. The system is in Test with Load.
2. The DMC receives the Protective Relay Failure signal from the 52-UM breaker.
3. “52-UM Protective Relay Failure” alarm is registered on the DMC.
4. The system will stay in Test with Load.
5. The operator can exit the Test with Load and the system will stay on the Generator Set source because the normal source is considered unavailable.

9.7.8 52-UM Breaker Protective Relay Failure Reset

1. The fault condition is cleared on the relay.
2. The operator resets the Protective Relay Failure alarm on the DMC.
3. If the Utility Source is available, the system will follow applicable Utility Return sequence based on active transition type.
4. If the Utility Source is not available, the active sequence continues.

9.8 52-GM Breaker Lockout Failures

9.8.1 52-GM Breaker Lockout during Utility Source Failure

The system will follow the same sequence if the Protective Relay failure happens on either or both of the transfer pairs.

1. The system is powered by Generator Set Source because of Loss of Utility Source.
2. The protective relay on the 52-GM breaker detects a Lockout condition.
3. The protective relay direct trips and locks out the 52-GM breaker.
4. “52-GM Lockout Trip” alarm is registered on the DMC.
5. The DMC will not close another source to the Loadbus until the lockout relay is reset.

6. If the other transfer pair requires Generator service, the system will continue the transfer to the Generator Source on the other Loadbus. The start signal will be turned off if there is no demand for Generator service.

9.8.2 52-GM Breaker Lockout Reset

1. The operator resets the lockout relay on the 52-GM breaker and resets the alarm on the DMC.
2. If the Utility Source is available, 52-UM breaker closes if no other source is online.

9.8.3 52-GM Breaker Lockout during Test with Load while Sources are in Parallel

The system will follow the same sequence if the Protective Relay failure happens on either or both of the transfer pairs.

1. The system is in Test with Load and both sources are connected.
2. The protective relay on the 52-GM breaker detects a Lockout condition.
3. The protective relay direct trips and locks out the 52-GM breaker.
4. “52-GM Lockout Trip” alarm is registered on the DMC.
5. The system is removed from Test with Load.
6. The facility remains powered by the Utility Source.
7. If the other transfer pair requires Generator service, the system will continue the transfer to the Generator Source on the other Loadbus. The start signal will be turned off if there is no demand for Generator Service.

9.8.4 52-GM Breaker Lockout Reset

1. The operator resets the lockout relay on the 52-GM breaker and resets the alarm on the DMC.
2. The system is in *Normal Standby Conditions.*

9.9 52-GM Breaker Protective Relay Failures

The DMC will not close the 52-GM breaker if it has the Protective Relay Failure alarm active.

9.9.1 52-GM Breaker Protective Relay Failure during Normal Standby Conditions

The system will follow the same sequence if the Protective Relay failure happens on either or both of the transfer pairs.

1. The system is in *Normal Standby Conditions.*
2. The DMC receives the Protective Relay Failure signal from the 52-GM breaker.
3. “52-GM Protective Relay Failure” alarm is registered on the DMC.
4. The Generator Set source is considered unavailable and the system will not respond to a normal source failure condition.
5. This alarm condition must be cleared and the system reset before the Generator Set source will be considered available.

9.9.2 52-GM Breaker Protective Relay Failure Reset

1. The fault condition is cleared on the relay.
2. The operator resets the Protective Relay Failure alarm on the DMC.
3. The system is in *Normal Standby Conditions.*

9.9.3 52-GM Breaker Protective Relay Failure during Utility Source Failure

The system will follow the same sequence if the Protective Relay failure happens on either or both of the transfer pairs.

1. The system is powered by Generator Set Source because of Loss of Utility Source.
2. The DMC receives the Protective Relay Failure signal from the 52-GM breaker.
3. “52-GM Protective Relay Failure” alarm is registered on the DMC.
4. The Generator Sets will continue to run and supply the load. The system will depend on the individual Generator Set protection in the PCC to protect the paralleling breakers and the Loadbus.
5. If the Protective Relay Failure happens before the 52-GM breaker closes in a Utility failure sequence, the Generator Sets will stop and the Generator Set Source will be considered not available. The loads will not be serviced.
6. If the Protective Relay Failure happens after the 52-GM breaker opens in a retransfer sequence, the retransfer will complete and loads will be serviced by the Utility Source.

9.9.4 52-GM Breaker Protective Relay Failure Reset

1. The fault condition is cleared on the relay.
2. The operator resets the Protective Relay Failure alarm on the DMC.
3. If the Utility Source is available, the system will follow applicable Utility Return sequence based on active transition type.

9.9.5 52-GM Breaker Protective Relay Failure during Test without Load

The system will follow the same sequence if the Protective Relay failure happens on either or both of the transfer pairs.

1. The system is in Test without Load.
2. The DMC receives the Protective Relay Failure signal from the 52-GM breaker.
3. “52-GM Protective Relay Failure” alarm is registered on the DMC.
4. The system will stay in Test without Load and the Generator Set source is considered unavailable and will not respond to a Utility Source failure condition.

9.9.6 52-GM Breaker Protective Relay Failure Reset

1. The fault condition is cleared on the relay.
2. The operator resets the Protective Relay Failure alarm on the DMC.
3. If the Utility Source is available, the system will follow applicable Utility Return sequence based on active transition type.

4. If the Utility Source is not available, the active Utility Failure sequence continues.

9.9.7 52-GM Breaker Protective Relay Failure during Test with Load

The system will follow the same sequence if the Protective Relay failure happens on either or both of the transfer pairs.

1. The system is in Test with Load.
2. The DMC receives the Protective Relay Failure signal from the 52-GM breaker.
3. “52-GM Protective Relay Failure” alarm is registered on the DMC.
4. The system will stay in Test with Load.
5. The Generator Sets will continue to run and supply the load. The system will depend on the individual Generator Set protection in the PCC to protect the paralleling breakers and the Loadbus.
6. The operator can exit the Test with Load and the system will stay on the Generator Set source because the normal source is considered unavailable.
7. If the Protective Relay Failure happens before the 52-GM breaker closes the test will be cancelled and the Generator Sets are stopped. The Generator Set Source will be considered not available. System will follow *the Test with Load Off (Auto – Open Transition)*

9.9.8 52-GM Breaker Protective Relay Failure Reset

1. The fault condition is cleared on the relay.
2. The operator resets the Protective Relay Failure alarm on the DMC.
3. If the Utility Source is available, the system will follow applicable Utility Return sequence based on active transition type.
4. If the Utility Source is not available, the active Utility Failure sequence continues.

9.10 Utility Source Failure during Test

9.10.1 Utility Source Failure during Test without Load

1. The system is in Test without Load.
2. The DMC receives a loss of Utility Source signal from the device monitoring the Utility Source.
3. The system is removed from Test without Load and the system will follow applicable Utility Source failure sequence.
4. When the Utility Source becomes available, the system will follow applicable Utility Return Sequence based on active transition type.
5. The system is in *Normal Standby Conditions* and will not reenter Test without Load automatically.

9.10.2 Utility Source Failure during Test with Load

The following sequence is applicable to either transfer pair.

1. The system is in Test with Load.
2. The DMC receives a loss of Utility Source signal from the device monitoring the Utility Source.

3. The DMC stays in Test with Load and the loads remain powered by the Generator Set source.
4. If The DMC receives a loss of Utility Source signal from the device monitoring the Utility Source for the Loadbus that is not in Test with Load, the system follows *Load Add Sequence during Loss of Utility Source* for the other Loadbus that requires Generator service.

The operator can choose to cancel the Test with Load at any time. If the Utility Source is available, the system will follow applicable Utility Return Sequence based on active transition type. If the Utility Source is not available, the system will exit the Test with Load but the Generator Sets will continue to power the loads without any interruption.

10 Failure Modes

10.1 Generator Set Failures

10.1.1 Generator Set Fail to Start

If a unit fails to start after the over crank or fail to crank time delay (time set in the PCC) expires, the unit shuts down and an alarm sounds on the DMC.

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AMRS Meter Specifications v.11.21.2024

Appendix 3

1.1 AMRS Electric Meter Specifications

The AMRS Compliant Electric Meter shall meet Department of Defense cybersecurity standards as well as the following requirements:

- Electric meters shall meet or exceed the ANSI C12.1-2022, 0.2 accuracy class standard
- Current transformers (CTs) shall meet or exceed the accuracy class of their associated electrical meter onboard memory
- Onboard Ethernet communications, 10/100 base with RJ45 connector or receptacle
- Modbus/TCP communication protocol is required
- Front display with ability to display all measured values
- Minimum of one (1) external RS485 serial communications port
- Minimum of two inputs that shall count pulses from other devices
- Electric meter enclosure shall be designed and constructed in accordance with UL508A to ensure safety and reduce the risk of electrical hazard
    - The assembler of the electric meter enclosure must be ISO 9000 certified
    - Electric meter enclosure shall include a UL-label on interior door
- Electric meter and enclosure when combined shall contain:
    - Stand-alone step-down transformer compatible with the system voltage that is being monitored, with a secondary voltage of 95-120v
    - 24V – 30W DC stand-alone DC power supply for external devices
    - Input/output terminal blocks

1.2 AMRS Compliant Meter List

The following list of meters were evaluated, meet the AMRS meter specification and shall function within the AMRS platform. All networked devices, their integrated firmware and software will be approved by the PMO for use in the AMRS. PMO approval is contingent upon the device, in its fielded configuration, passing USAF cyber and AMRS compatibility testing.

- Schneider Electric PM8000
- Schneider Electric ION 9000
- Siemens 9410
- Siemens 9810

1.3 Meter Installation Guidelines

- Contractor shall assume all existing equipment is working properly. If, during the post award survey portion of the SOW, an existing piece of equipment is found to be malfunctioning, then the contractor shall bring it to the government's attention via the submittal of an RFI to determine how to proceed. This may require a contract change to delete this meter from the scope or to add a new meter.
- All due diligence to survey the existing site conditions is the responsibility of the contractor.
- New electric meter enclosures shall be installed in interior locations, located 5 feet above finished floor level, and as close to the main distribution panel as possible. All metering device labels shall be white on black phenolic no smaller than 1” x 3”
- New meter installations shall include the installation of new, properly sized, split or solid core CTs as deemed to physically fit upon inspection by the contractor. It is part of due

diligence of the contractor to design and install appropriately sized CTs into the space offered within the system. Rope-style or Rogowski CTs are not authorized.

- Existing non fuctional CTs are to be removed if possible. If removal is not possible, existing non functional CTs must be shorted out.
- If CT or voltage tap installation method includes disturbing the bonds of existing cables or wiring within the gear, before and after IR scans shall be performed before removing and after torqueing the connections to ensure the integrity of the conductor bonds.
- CTs shall be insulated. It is the responsibility of the contractor to design and install CTs of the appropriate amperage and size to accommodate the full load of existing gear. If the contractor intends to size the CTs from the breaker size, rather than the gear size, a RFI must be submitted requesting review and approval of said deviation.
- Meter enclosures shall include fused, finger safe voltage disconnects and CT shorting blocks. Instructions explaining how to operate the CT shorting blocks must be visible inside each meter enclosure.
- The meter must not require utility outages for servicing.
- The CT shorting block ground wires must be installed on the load side.
- Meters shall have control power regardless of breaker position.
- All meter enclosures shall be fed by a load break 3-pole fusible disconnect switch that is external of the meter assembly. This safety disconnect switch shall be marked as follows "Meter Disconnect NOT Service Equipment" and any additional NEC labeling requirements.
- New electric meter supply voltages shall be acquired by means of voltage taps from the bus or system breakers for the voltage system that the AMRS meter is monitoring. Insulation piercing connectors are not an approved method and energized electrical work will not be permitted.
- Electric meters with connected gas or water meter inputs shall have two internal registers configured - one for a raw pulse count and one for a weighted pulse count based on the scaling of the connected gas or water meter. It is the responsibility of the contractor to ensure that scaling ratios configured into the electric meter/device are accurate.
- All new communications equipment and metering devices are required to be enclosed in a lockable NEMA 4 or NEMA 4X enclosure. No other enclosure types are approvable for this project regardless of installation location. Communications equipment must be installed in a separate enclosure than the meter enclosure.
- Communication equipment and metering equipment should never be installed in an exterior location. In the event the contractor would like the government to consider communications equipment and/or a metering device to be located in an exterior location, a RFI must be submitted for review. If approved, the exterior meter enclosure must be a lockable NEMA 4X, stainless steel enclosure with panel that can completely cover the face of the meter and protect it from all environmental elements.

1.4 Cabling Installation Guidelines

- New meter installations shall be connected via CAT6 cable from the meter, to a wall outlet in the electrical room, to a patch panel in the communications room, and then to the AFnet switch in the communications room (base communication squadron will make the last connection to the AFnet switch).

- All CAT6 cable runs must be continuous from the wall outlet to the patch panel with no intermediate patches or cross connects and are not to exceed 328 linear feet including patch cords.
- The contractor shall verify the CAT6 cable termination standard, T568A or T568B, with the base comm squadron prior to cable installation
- Required technical approach to network communication cabling in excess of 328 feet is: fiber optic cable and fiber media converters with lockable enclosures and dedicated power outlets.
- If FIBER is required a minimum of two (2) strands are required per device connection.
- TIAA compliant fiber media converter shall be installed in the communications room as close as possible to the network switch and as close as possible to the electric meter enclosure.
- All cabling not installed above ceilings or behind walls shall be protected by conduit
- Communication receptacles accessible to the general public must be installed in lockable enclosures.
- Cable labels shall be permanent, wrap-around and self-laminating with text generated by a mechanical device. Labels shall be applied at both ends of the cable, visible during normal maintenance of the infrastructure and resistant to environmental conditions.
- All data cable test results (including fiber) shall be completed only after the cable has been terminated in its permanent location, temporary cable test results will not be accepted.
- Surge protection is required on all communication cabling extending from the exterior to the interior of a facility. This includes gas and water meter communication cables from the exterior to the interior of the building.
- Surge suppression devices shall be installed w/in 3 feet of the building entrance inside the facility. Devices shall be easily accessible and labeled to aide in location during future troubleshooting efforts.
- Surge protection devices shall be Power over Ethernet (PoE) compatible and housed within a lockable enclosure that allows space for a proper cable bend radius.
- Fiber optic cable strands shall be terminated on patch panel bulkheads or within a fiber optic wall outlet assembly; unsecured connectors are not acceptable.
- Fiber optic cable runs must use continuous fiber with no intermediate patches or cross connects and must not use mechanical splices or end terminations; all splices and terminations shall be fusion spliced.

2.0 AMRS Compatible Gas Meter Specifications

AMRS compatible gas metering solutions rely on accurately scaled output pulses, properly sized components according to peak demand, and peak pulse rates to eliminate the risk of saturating the receiving device ensuring the loss-less delivery of accurate gas pulse data into the AMRS system. The due diligence of the contractor shall be to coordinate with the appropriate base personnel to obtain all necessary information to effectively design and build a system that satisfies these requirements and conforms to the following specifications:

- Pulse kit must be able to produce a two-wire (Form A) pulse output via exterior rated RS485 cable in conduit
- Gas meter or attached pulse kit must include a visual register or dial
- All new gas meter assemblies shall include upstream gasket strainers
- All meter labels shall be white on black phenolic

- All cabling not installed above ceilings or behind walls shall be protected by conduit

3.0 AMRS Compatible Water Meter Specifications

AMRS compatible water metering solutions rely on accurately scaled output pulses, properly sized components according to peak demand, and peak pulse rates to eliminate the risk of saturating the receiving device ensuring the loss-less delivery of accurate water pulse data into the AMRS system. The due diligence of the contractor shall be to coordinate with the appropriate base personnel to obtain all necessary information to effectively design and build a system that satisfies these requirements and conforms to the following specifications:

- Pulse kit must be able to produce a two-wire (Form A) pulse output via RS485 cable
- Water meter or attached pulse kit must include a visual register or dial
- All new water meter assemblies shall include upstream bronze wye strainers
- All meter labels shall be white on black phenolic
- All cabling not installed above ceilings or behind walls shall be protected by conduit

4.0 AMRS Compatible Translation Devices and Accumulators

The device(s) listed below are compatible with the AMRS platform, have been tested and passed cybersecurity requirements. Please note that they will only be approved for use on a case-by-case basis when dictated by unique existing site conditions. All translation devices and accumulators require lockable enclosures and dedicated power outlets.

- Schneider Electric PAS 600L EcoStruxure Panel Server

SSR# 20231115a

Jan 05, 2024

To Whom It May Concern:

With regards to Cummins manufactured diesel generator set model DQLE rated for 60 Hz operation at 13200 volts, equipped with Cummins QSK78-G12 engine, Stamford alternator model S9H1D-F4 Wdg.991 with 105°C/40°C temperature rise class and Cummins set-mounted high ambient cooling system:

When applied at the site of:

Buckley Space Force Base
Space Force CEB
Buckley Space Force Base,
Aurora, CO 80011
US

With ambient design conditions of 38.8°C (102°F) as measured at the equipment room inlet and inclusive of engine and alternator heat rejection to the equipment room, with a maximum external cooling system restriction of 0.125 kPa (0.5 inches of water), and 1693 meters (5555 feet) above mean sea level, the generator set is capable of operating at a Data Center Continuous (DCC) rating of 1600 kWe / 2000 kVA for unlimited hours when installed per Cummins application guidelines, as per the requirements of the Uptime Institute.

Maintenance intervals, including time to overhaul, will be directly correlated to the actual run hours and load levels to which the generator set is applied. Therefore, maintenance intervals should be aligned with the actual use of the generator set as described in the Operator's and Service manuals. This letter does not supersede any of the commercial terms of sale, including, but not limited to, warranty coverage.

Cummins approves this rating; however, if ever these generator sets are operated in a different application, the power distribution system is modified or there is any other change to the site design conditions, Cummins must be notified and further actions may need to be taken.

For further questions on this product or application, please contact the local Cummins distributor.

Best Regards,

Ashish R Gupta
Sales Application Engineer- Technical Specialist
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ELECTRICAL DISTRIBUTION SYSTEM
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C57.12.01	(2020) General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings
IEEE C57.12.51	(2019) IEEE Guide for Mechanical Interchangeability of Ventilated Dry-Type Transformers
IEEE C57.12.80	(2010) Standard Terminology for Power and Distribution Transformers
IEEE C57.12.91	(2011) Standard Test Code for Dry-Type Distribution and Power Transformers
IEEE C57.98	(2011) Guide for Transformer Impulse Tests

IEEE C57.124	(1991; R 2002) Recommended Practice for the Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2020) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2020) American National Standard for Electrical Metallic Tubing (EMT)
ANSI C80.5	(2020) American National Standard for Electrical Rigid Aluminum Conduit
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA BU 1.1	(2010) General Instructions for Proper Handling, Installation, Operation and Maintenance of Busway Rated 600 V or Less
NEMA FU 1	(2012) Low Voltage Cartridge Fuses
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA MG 1	(2021) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase

	Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA VE 1	(2017) Metal Cable Tray Systems
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2021) Wiring Devices Dimensions Specifications
NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems
TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)	
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)	
10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)

29 CFR 1910.303	Electrical, General

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-520-01	(2015; with Change 2, 2021) Interior Electrical Systems
UFC 3-540-01	(2014; with Change 2, 2019) Engine-Driven Generator Systems for Prime and Standby Power Applications

UL SOLUTIONS (UL)

UL 1	(2005; Reprint Jan 2022) UL Standard for Safety Flexible Metal Conduit
UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 6A	(2008; Reprint Mar 2021) UL Standard for Safety Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
UL 20	(2018; Reprint Jan 2021) UL Standard for Safety General-Use Snap Switches
UL 44	(2018; Reprint May 2021) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint Jul 2020) UL Standard for Safety Panelboards
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 248-4	(2010; Reprint Apr 2019) Low-Voltage Fuses - Part 4: Class CC Fuses
UL 248-8	(2011; Reprint Aug 2020) Low-Voltage Fuses - Part 8: Class J Fuses
UL 248-10	(2011; Reprint Aug 2020) Low-Voltage Fuses - Part 10: Class L Fuses
UL 248-12	(2011; Reprint Aug 2020) Low Voltage Fuses - Part 12: Class R Fuses
UL 248-15	(2018) Low-Voltage Fuses - Part 15: Class T Fuses
UL 360	(2013; Reprint Aug 2021) UL Standard for Safety Liquid-Tight Flexible Metal Conduit

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint May 2021) UL Standard for Safety Wire Connectors
UL 486C	(2018; Reprint May 2021) UL Standard for Safety Splicing Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2017; Reprint Jan 2022) UL Standard for Safety Specialty Transformers
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2013; Reprint Jun 2022) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint May 2020) Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 674	(2022) UL Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations
UL 698A	(2018; Rev 2019) UL Standard for Safety Industrial Control Panels Relating to Hazardous (Classified) Locations
UL 797	(2007; Reprint Mar 2021) UL Standard for Safety Electrical Metallic Tubing -- Steel
UL 854	(2020; Reprint Jan 2022) Standard for Service-Entrance Cables
UL 857	(2009; Reprint Apr 2021) UL Standard for Safety Busways
UL 869A	(2006; Reprint Jun 2020) Reference Standard for Service Equipment
UL 870	(2016; Reprint Mar 2019) UL Standard for Safety Wireways, Auxiliary Gutters, and

	Associated Fittings
UL 877	(1993) Standard for Safety Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 886	(1994) Standard for Safety Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 984	(1996; Reprint Sep 2005) Hermetic Refrigerant Motor-Compressors
UL 1008	(2022) UL Standard for Safety Transfer Switch Equipment
UL 1010	(2006) Standard for Safety Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations
UL 1063	(2017; Reprint Jun 2022) UL Standard for Safety Machine-Tool Wires and Cables
UL 1203	(2013; Reprint Apr 2022) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations
UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1561	(2011; Reprint Jun 2015) Dry-Type General Purpose and Power Transformers
UL 1569	(2018) UL Standard for Safety Metal-Clad Cables
UL 1660	(2019; Reprint Jan 2022) Liquid-Tight Flexible Nonmetallic Conduit
UL 1699	(2017; Reprint Feb 2022) UL Standard for Safety Arc-Fault Circuit-Interrupters
UL 4248-1	(2022) UL Standard for Safety Fuseholders - Part 1: General Requirements
UL 4248-12	(2018; Reprint Feb 2022) UL Standard for Safety Fuseholders - Part 12: Class R

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Shop drawings shall include detailed connection wiring diagrams and indicate all processors/platforms and connections to other systems such as SCADA, UMCS, Smart Metering or other. Identify the smart meter (utility metering) enclave and SCADA enclave. Provide all documentation necessary for Risk Management Framework. Refer to Section 25 05 11.05 Cybersecurity of Facility-Related Control Systems - Generator/Switchgear.

SD-02 Shop Drawings

Underground Conduit Routing Plan; G, DO

Panelboards; G, DO

This item may (and are encouraged to) be submitted for preliminary review only prior or concurrent to the submittal and approval of the Section 26 05 73 analyses.

Submit this item after or concurrent to Section 26 20 00 Item: CFCI Equipment Electrical Data.

Final CFCI Equipment Electrical Data; G, DO

Submit CFCI Equipment Electrical Data prior to or concurrent with Panelboards, Circuit Breakers (including enclosed), Low- to Low-Voltage Transformer, and Switches (26 20 00); Switchboards (and associated items; 26 24 13); and Section 26 05 73 studies and analyses.

Interim CFCI Equipment Electrical Data; G, DO
Interim CFCI Equipment Electrical Data (Fire Alarm); G, DO
Interim CFCI Equipment Electrical Data (Generator Station Service); G, DO
Interim CFCI Equipment Electrical Data (Filter Shelter); G, DO
Interim CFCI Equipment Electrical Data (Offload); G, DO

Busway; G, DO

Cable Trays; G, DO

Wireways; G, DO

Switchgear; G, DO

Marking Strips Drawings; G, DO

SD-03 Product Data

Receptacles; G, DO

Circuit Breakers (Switchboards); G, DO

Circuit Breakers (Other then Switchboards); G, DO

Switches; G, DO

Manual Transfer Switch; G, DO

Low- to Low-Voltage Transformers; G, DO

Submit Low- to Low-Voltage Transformers prior to or concurrent with Panelboards, Circuit Breakers (including enclosed), and Switches (26 20 00); Switchboards (and associated items; 26 24 13); and Section 26 05 73 studies and analyses.

Medium- to Low-Voltage Transformers; G, DO

Enclosed Circuit Breakers; G, DO

Motor Controllers; G, DO

Manual Motor Starters; G, DO

Metering; G, DO

Secondary Bonding Busbar; G, DO

Surge Protective Devices; G, DO

Cable Trays; G, DO

Adjustable Circuit Breaker Settings Cover; G, DO

Circuit Breaker Handle Locks and Lock-out Device; G, DO

Sealoffs; G, DO

Conductor Termination Adapters; G, DO

SD-05 Design Data

Cable Tray Design; G, DO

SD-06 Test Reports

600-volt Wiring Test; G, RO

Grounding System Test; G, RO

Low- to Low-Voltage Transformer Tests; G, RO

Medium- to Low-Voltage Transformer Tests; G, RO

Ground-fault Receptacle Test; G, RO

Arc-fault Receptacle Test; G, RO

SD-07 Certificates

Fuses; G, RO

SD-09 Manufacturer's Field Reports

Low- to Low-Voltage Transformer Factory Tests

Medium- to Low-Voltage Transformer Factory Tests

SD-10 Operation and Maintenance Data

Electrical Systems, Data Package 5; G, RO

Metering, Data Package 5; G, RO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 QUALITY ASSURANCE

1.4.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless more stringent requirements are specified or indicated. NECA NEIS 1 shall be considered the minimum standard for workmanship.

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.5 MAINTENANCE

1.5.1 Electrical Systems

Submit operation and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein. Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:

a. Single line diagram of the "as-built" building electrical system.

b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

c. Manufacturers' operating and maintenance manuals on active electrical equipment.

1.6 WARRANTY

Provide equipment items supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7 SEISMIC REQUIREMENTS

Provide seismic details conforming to Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and to Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

1.8 Underground Conduit Routing Plan

Provide a plan expressing conduits routing underground both within the footprint of the building and those entering and/or exiting the building footprint (including those captured be Section 33 82 00). See coordinated submittal requirements regarding this submittal item with respect to impacted submittal content by other trades, most notably alterations and accommodations of footing reinforcement for conduit and ductbank with vertical routing through the footings.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment,

and devices.

2.2 CONDUIT AND FITTINGS

Conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6.

2.2.1.2 Rigid Aluminum Conduit

ANSI C80.5, UL 6A.

2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-40, and EPC-80 in accordance with NEMA TC 2,UL 651.

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3.

2.2.5 Plastic-Coated Rigid Steel and IMC Conduit

NEMA RN 1, Type 40(40 mils thick).

Due to low soil resistivity measured at the site (leading to a "severe" corrosion potential), all non-concrete encased underground metallic conduits shall be plastic-coated.

2.2.6 Flexible Metal Conduit

UL 1, limited to 6 feet.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360, limited to 6 feet.

2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings: cadmium- or zinc-coated in accordance with UL 514B.

2.2.7.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7.2 Fittings for EMT

Steel compression type.

2.2.8 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC, and UL 514B.

2.2.9 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

2.3 BUSWAY

NEMA BU 1.1, UL 857. Provide the following:

a. Buses: copper.

b. Busways: rated 480 volts, 1200 continuous current amperes, three-phase, four-wire, and include integral or internal 50-percent ground bus.

c. Short circuit rating: 42,000 root mean square (rms) symmetrical amperes minimum.

d. Busway systems: suitable for use indoors.

e. Enclosures: metallic.

f. Hardware: plated or otherwise protected to resist corrosion.

g. Joints: one-bolt type with through-bolts, which can be checked for tightness without de-energizing system.

h. Maximum hot spot temperature rise at any point in busway at continuous rated load: do not exceed 55 degrees C above maximum ambient temperature of 40 degrees C in any position.

i. Internal barriers to prevent movement of superheated gases.

j. Coordinate proper voltage phasing of entire bus duct system, for example where busway interfaces with transformers, switchgear, switchboards, motor control centers, and other system components.

2.3.1 Feeder Busways

Provide ventilated, except that vertical busways within 6 feet of floors must be unventilated, low-impedance busway. Provide bus bars fully covered with insulating material, except at stabs. Provide an entirely polarized busway system.

2.4 CABLE TRAYS

NEMA VE 1. Provide the following:

Submit cable tray design, including dimensional layout, load and seismic calculations, and fill calculations. Dimensional layout includes cable spacings, cable tray splices, and supports. Fill calculations include an index of cables for each section and identification of the lb/ft, cross sectional area, and insulation voltage class for each cable. At the contractor's discretion, cable tray may be installed rooms with the term "Switchgear" (four rooms) for ease of installation and maintenance complying with NFPA 70.

a. Cable trays: form a wireway system, with a nominal 4 inch depth.

b. Cable trays: constructed of aluminum.

c. Cable trays: include splice and end plates, dropouts, and miscellaneous hardware.

d. Edges, fittings, and hardware: finished free from burrs and sharp edges.

e. Fittings: ensure not less than load-carrying ability of straight tray sections and have manufacturer's minimum standard radius.

f. Radius of bends: 12 inches but in no case shall be less than required to maintain manufacturers minimum cable bending radii.

2.4.1 Basket-Type Cable Trays

Provide sized to meet cabling capacity requirements with maximum wire mesh spacing of 2 by 4 inch. Cable tray to accommodate initial fill ratio of 25% and to not exceed 50% fill ratio.

2.4.2 Ladder-Type Cable Trays - For use in all Communication Rooms

Provide size as indicated with maximum rung spacing of 9 inches. Tray must be installed with the proper mounting hardware to securely fasten the tray to the walls and the top of the Floor-Mounted Racks. Tray shall be equipped with the proper grounding lugs to assure proper grounding and bonding of the tray. Provide side walls extending above the ladder rungs for the nominal height indicated on plans (Basis of Design: Legrand PW Ladder Cable Tray).

2.5 OPEN TELECOMMUNICATIONS CABLE SUPPORT

Open telecommunications cable support shall not be used.

2.6 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.6.1 Outlet Boxes for Telecommunications System

Provide the following:

a. Standard type 4 11/16 inches square by 2 1/8 inches deep.

b. Outlet boxes for single-connector, wall-mounted telecommunications phone outlets may be single-gang 4 by 2 1/8 by 2 1/8 inches deep.

c. Depth of boxes: large enough to allow manufacturers' recommended conductor bend radii.

2.7 CABINETS, JUNCTION BOXES, AND PULL BOXES

UL 50; volume greater than 100 cubic inches, NEMA Type 1 enclosure; sheet steel, hot-dip, zinc-coated. Where exposed to wet, damp, or corrosive environments, NEMA Type .

Reference E-### series sheets for environmental condition requirements (including hazardous locations) and provide appropriate cabinet, junction box, pull box, and terminal box enclosures, hubs, and connections for the conditions indicated.

2.8 WIRES AND CABLES

Provide wires and cables in accordance applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 12 months prior to date of delivery to site.

2.8.1 Conductors

Provide the following:

a. Conductor sizes and capacities shown are based on copper, unless indicated otherwise.

b. Conductors No. 8 AWG and larger diameter: stranded.

c. Conductors No. 10 AWG and smaller diameter: solid.

d. Conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3: stranded unless specifically indicated otherwise.

e. All conductors: copper.

2.8.1.1 Minimum Conductor Sizes

Provide minimum conductor size in accordance with the following:

a. Branch circuits: No. 12 AWG.
The branch circuit sizes listed on the plans are minimum values. However, should a larger conductor size (with a larger diameter) be installed, the contractor is responsible for re-sizing raceways to account for the NFPA 70 fill ratio requirements.

b. Class 1 remote-control and signal circuits: No. 14 AWG.

c. Class 2 low-energy, remote-control and signal circuits: No. 16 AWG.

d. Class 3 low-energy, remote-control, alarm and signal circuits: No. 22 AWG.

e. Digital low voltage lighting control (DLVLC) system at 24 Volts or less: Category 5 UTP or better cables in accordance with DLVLC system manufacturer requirements. See Sheet TN500 for jacket color.

2.8.2 Color Coding

Provide color coding for service, feeder, branch, control, and signaling circuit conductors. Feeders shall be identified in accordance with NFPA 70 Article 215.12.

2.8.2.1 Ground and Neutral Conductors

Provide color coding of ground and neutral conductors as follows:

a. Grounding conductors: Green.

b. Neutral conductors: White.

c. Exception, where neutrals of more than one system are installed in same raceway or box, other neutrals color coding: white with a different colored (not green) stripe for each.

2.8.2.2 Ungrounded Conductors

Provide color coding of ungrounded conductors in different voltage systems as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 120/240 volt, single phase: Black and red

d. On three-phase, four-wire delta system, high leg: orange, as required by NFPA 70.

2.8.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, provide power and lighting wires rated for 600-volts, Type THWN/THHN conforming to UL 83 or Type XHHW conforming to UL 44, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits: Type TW or TF, conforming to UL 83. Where equipment or devices require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

For service entrance conductors, provide insulated conductors rated 600 volts and conforming to the requirements of NFPA 70, including listing requirements. Wires and cables manufactured more than 24 months prior to date of delivery to the site are not acceptable. Service entrance conductors must conform to UL 854, type USE.

Insulation values listed on the plans are minimum values (see "PANEL SCHEDULE KEY" entry for "MCIT" for final insulation value instructions). However, should a higher insulation value with a larger diameter be installed, the contractor is responsible for re-sizing raceways to account for the NFPA 70 fill ratio requirements.

2.8.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.8.4.1 Telecommunications Bonding Backbone (TBB)

Provide a copper conductor TBB in accordance with TIA-607 with No. 6 AWG minimum size, and sized at 2 kcmil per linear foot of conductor length up to a maximum size of 750 kcmil. Provide insulated TBB with insulation as specified in the paragraph INSULATION and meeting the fire ratings of its pathway.

2.8.4.2 Bonding Conductor for Telecommunications

Provide a copper conductor Bonding Conductor for Telecommunications between the telecommunications main grounding busbar (PBB) and the electrical service ground in accordance with TIA-607. Size the bonding conductor for telecommunications the same as the TBB. Reference EG600 for minimum grounding bonding conductor sizes.

2.8.5 Service Entrance Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

2.8.6 Wire and Cable for 28 VDC Circuits

Insulated copper conductors.

2.8.7 Metal-Clad Cable

UL 1569; NFPA 70, Type MC cable.

2.8.8 Cable Tray Cable or Power Limited Tray Cable

UL listed; type TC or PLTC.

2.9 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires: insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Must provide a uniform compression over the entire conductor contact surface. Provide solderless terminal lugs on stranded conductors.

2.10 DEVICE PLATES

Provide the following:

a. UL listed, one-piece device plates for outlets to suit the devices installed.

b. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.

c. For nonmetallic boxes and fittings, other suitable plates may be provided.

d. Plates on finished walls: stainless steel,nylon or lexan, minimum 0.03 inch wall thickness and same color as receptacle or toggle switch with which they are mounted.

f. Screws: machine-type with countersunk heads in color to match finish of plate.

g. Sectional type device plates are not be permitted.

h. Plates installed in wet locations: gasketed and UL listed for "wet locations."

2.11 SWITCHES

2.11.1 Toggle Switches

NEMA WD 1, UL 20, single pole, double pole, three-way, and four-way, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:

a. Handles: light gray thermoplastic.

b. Wiring terminals: screw-type, side-wired.

c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.

d. Switches: rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated. Provide two-pole switch where indicated for 480V lighting circuits. See Equipment Electrical Connection Schedule for toggle switches which are required to be motor-rated (with thermal overloads) and/or a rating of 30A rather than 20A.

Switch sizes identified on plans are minimum sizes, and the contractor is responsible for increasing sizes to account for increased current drawn based on requirements of contractor-furnished equipment and/or for termination compatibility with conductor sizes increased due to voltage drop mitigation requirements and/or conductor ampacity corrections/adjustments for the ambient temperature or number of current-carrying conductors. (Additionally, see Subparts "Conductor Termination Adapters" and "CFCI Equipment Electrical Data")

2.11.2 Switch with Red Pilot Handle

NEMA WD 1. Provide the following:

a. Pilot lights that are integrally constructed as a part of the switch's handle.

b. Pilot light color: red and illuminate whenever the switch is closed or "on".

c. Pilot lighted switch: rated 20 amps and 120 volts as indicated.

d. The circuit's neutral conductor to each switch with a pilot light.

2.11.3 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Utilize Class R fuseholders and fuses for fused switches, unless indicated otherwise. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches in NEMA,. Provide switches in enclosure rated per NEMA ICS 6 and as indicated on the plans.

2.11.4 Manual Transfer Switch

Provide UL 1008 double-throw, manual/non-automatic transfer switches of configuration, NEMA ICS 6 enclosure rating, and minimum size indicated on EP600 series sheets. Provide service-entrance rated equipment where indicated.

Where indicated, manual/non-automatic transfer switches shall be equipped with a normally open relay output which closes upon transfer to the alternate power source.

2.11.5 Switches Associated with Fire Alarm or Similar Equipment

Switches associated with fire alarm devices/equipment or similar equipment shall be red. Reference the panel schedules for circuits identified with notes as being "FIRE PROTECTION/LIFE SAFETY EQUIPMENT".

2.12 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch. Coordinate time-current characteristics curves of fuses serving motors or connected in series with circuit breakers or other circuit protective devices for proper operation. Submit coordination data for approval. Provide fuses with a voltage rating not less than circuit voltage.

2.12.1 Fuseholders

Provide in accordance with UL 4248-1.

2.12.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 248-12, Class RK-1. Provide only Class R associated fuseholders in accordance with UL 4248-12.

2.12.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 248-8, UL 248-10, UL 248-4, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.12.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 248-15, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.13 RECEPTACLES

Provide the following:

a. UL 498, general purpose specification grade, grounding-type.

Residential grade receptacles are not acceptable.

b. Ratings and configurations: as indicated.

c. Bodies: light gray as per NEMA WD 1.

d. Face and body: thermoplastic supported on a metal mounting strap.

e. Dimensional requirements: per NEMA WD 6.

f. Screw-type, side-wired wiring terminals or of the solderless pressure type having suitable conductor-release arrangement.

g. Grounding pole connected to mounting strap.

h. The receptacle: containing triple-wipe power contacts and double or triple-wipe ground contacts.

i. Controlled receptacles: as required per ASHRAE 90.1. Provide marking for controlled receptacle per NFPA 70.

2.13.1 Weatherproof Receptacles

Provide receptacles, UL listed for use in "wet locations" with integral GFCI protection. Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, die-cast metal/aluminum cover plate.

2.13.2 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Provide device capable of detecting current leak when the current to ground is 6 milliamperes or higher, and tripping per requirements of UL 943 for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.13.3 Plugs

Provide heavy-duty, rubber-covered three-, four-, or five-wire cord of required size, install plugs thereon, and attach to equipment. Provide UL listed plugs with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the Government.

2.13.4 Tamper-Resistant Receptacles

Provide duplex receptacle with mechanical sliding shutters that prevent the insertion of small objects into its contact slots.

2.13.5 Arc-Fault Circuit Interrupter Receptacles

UL 1699, duplex type for mounting in standard outlet box. Provide device capable of detecting series arcing current when the current to ground is 5 amperes or higher, and tripping per requirements of UL 1699.

2.13.6 Hazardous-Rated Receptacles

Provide UL-listed receptacles rated for Class I Division II locations as appropriate based on hazardous plans on E-### series sheets and as depicted on plans.

2.14 PANELBOARDS

Provide panelboards in accordance with the following:

a. UL 67 and UL 50 having a minimum short-circuit current rating as indicated on the drawings or as established by the studies required by Section 26 05 73, POWER SYSTEMS STUDIES, whichever is greater.

b. Panelboards for use as service disconnecting means: additionally conform to UL 869A.

c. Panelboards: circuit breaker-equipped.

d. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.

e. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the design drawings. Include in submittal a narrative explanation in situations where "Specific breaker placement" is not possible due to equipment/device limitation(s). A variance request for relocation is required and is subject to government review and approval.

f. Use of "Subfeed Breakers" is not acceptable.

g. Main breaker: "separately" mounted "above" or "below" branch breakers.

h. Where "space only" is indicated, make provisions for future installation of breakers.

i. Directories: indicate load served by each circuit in panelboard. Use the load names in the panel schedules as a basis, however, omit commentary items in "< >" (such as "< BID OPTION >") of a given circuit. Directories shall represent the final installed condition of the panelboard circuits (such as spares and spaces in place of anticipated or contingency circuits); some circuits indicated on plans are contingent upon base or bid option award or upon the equipment selected by the contractor. For equipment connections requiring receptacles and a receptacle is not shown as the basis of design connection, add "RECEPTACLE" to the load name similar to equipment connected by receptacle already shown; likewise, where a receptacle is indicated but the equipment installed requires a different connection, remove "RECEPTACLE" from the load name in the directory.

j. Directories: indicate source of service to panelboard (e.g., Panel PA served from Panel MDP in Room ###).

l. Type directories and mount in holder behind transparent protective covering.

m. Panelboards: listed and labeled for their intended use.

n. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

o. Submit panelboard elevation drawings indicating at minimum the

following:

(1) Circuit breaker and space layout.
(2) Circuit breaker rating, poles, and model information.
(3) Name of load assigned to each circuit (may be omitted in situations where all circuit breakers are identical (such as all 20A circuit breakers on a lighting panel) or the individual differences are obvious (a few are lockable or GFCI).
(4) Branch circuit frame size mismatch/limitations (if applicable).
(5) Enclosure dimensions.
(6) Enclosure ratings (NEMA ICS 6, bus, SCCR, etc.).
(7) Enclosure properties (bus material, mounting, SE label, series rated, system voltage, number of sections).
(8) Components list and options included.
(9) Dimension from floor to center of highest operating handle for NFPA 70 compliance (6 ft 7 in).
(10) The mounting height to bottom to demonstrate elevation above hazardous areas (where applicable), and allow for the proper installation of conduits entering the bottom of equipment and the associated sealoff (where applicable).

p. Submit bill of materials for each panelboard to include quantities and catalog number of each component.

Reference Section 28 31 70 Subpart "Primary Power" for coordination of devices and equipment to be supplied from the "Dedicated Emergency Panel Schedule". Final approval for distribution equipment covered by this Section for elements pertaining to the fire alarm and related systems will not be considered until the Section 28 31 70 "Dedicated Emergency Panel Schedule" is approved, which requires a substantially-developed fire alarm/etc. systems design; Coordinate across trades for timely delivery of this information.

2.14.1 Enclosure

Provide panelboard enclosure in accordance with the following:

a. UL 50.

b. Cabinets mounted outdoors or flush-mounted: hot-dipped galvanized after fabrication .

c. Cabinets: painted in accordance with paragraph PAINTING.

d. Outdoor cabinets: NEMA 4x with conduit hubs welded to the cabinet.

e. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.

f. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 1/8 inch.

g. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface.

h. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.

i. Each door: fitted with a combined catch and lock latch and provided with a hinged trim assembly.

j. Keys: two provided with each lock, with all locks keyed alike.

k. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.

2.14.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet. In addition to equipment grounding bus, provide second "isolated" ground bus, where indicated.

2.14.2.1 Panelboard Neutrals for Non-Linear Loads

Panel schedules shown on the plans with 200% neutral shall be considered panelboards supporting non-linear loads. Provide in accordance with the following:

a. UL listed, with panelboard type specifically UL heat rise tested for use on non-linear loads.

b. Panelboard: heat rise tested in accordance with UL 67, except with the neutral assembly installed and carrying 200 percent of the phase bus current during testing.

c. Verification of the testing procedure: provided upon request.

d. Two neutral assemblies paralleled together with cable is not acceptable.

e. Nameplates for panelboard rated for use on non-linear loads: marked "SUITABLE FOR NON-LINEAR LOADS" and in accordance with paragraph FIELD FABRICATED NAMEPLATES.

f. Provide a neutral label with instructions for wiring the neutral of panelboards rated for use on non-linear loads.

2.14.3 Circuit Breakers

To ease grouping of submittals in coordination and sequencing, furnish information as "Circuit Breakers (Switchboards)" and "Circuit Breakers (Other then Switchboards)"

UL 489, having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals: UL listed as suitable for type of conductor provided. Where indicated on the drawings, provide circuit breakers with shunt trip devices. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

UL 489 solid-state circuit breakers shall be used where indicated on the plans and in Section 26 05 73 POWER SYSTEM STUDIES. Thermal-magnetic type shall be used in all locations not indicated to be solid-state type.

The circuit breaker ratings indicated on the panel schedules are estimates based on basis of design equipment or standard ratings. Both solid-state and thermal magnetic-type circuit breaker ratings and/or settings are subject to change based on the manufacturer recommendations for equipment to be provided in this contract, including transformer inrush values and values for equipment listed on the "Equipment Electrical Connection Schedule". Contractor shall coordinate the protection device ratings with the equipment approved to be installed, is responsible for providing the appropriate ratings/settings, and shall indicate deviations from the design ratings in the submittal process.

Reference Section 28 31 70 Section "Primary Power" for coordination of devices and equipment to be supplied from the "Dedicated Emergency Panel Schedule". Final approval for distribution equipment covered by this Section for elements pertaining to the fire alarm and related systems will not be considered until the Section 28 31 70 "Dedicated Emergency Panel Schedule" is approved, which requires a substantially-developed fire alarm/mass notification/releasing service/containment/etc. systems design; Coordinate across trades for timely delivery of this information.

Specific specialty type circuit breakers found on the plans and schedules including but not limited to GFCI, AFCI, shunt trip, devices with red handles, and those lockable in the ON and/or OFF position (or appurtenances used for the satisfaction of said requirements) shall be included in the Circuit Breakers submittal.

Circuit breaker types shall be based on the protective coordination study to selectively coordinate to the degree indicated in Section 26 05 73 POWER SYSTEM STUDIES. Circuit breaker types shall be adjusted in accordance with the recommendations resulting from the studies performed. However, adjustments shall not be performed which compromise the criteria- or manufacturer-required protection of equipment (such as NFPA 70 Section 450.3 primary and secondary protection limits for transformers or manufacturer-recommended MOCP values, respectively). Examples of such adjustments are changing from one model line of a given manufacturer to another for specific troublesome protective devices preventing an acceptable level of coordinated protection selectivity (such as from Siemens HGB or BQD to Siemens FXD6, from Siemens BQD for Siemens NGB, from Siemens BL for Siemens BLH). Circuit breakers shall not be considered accepted until protective coordination study is accepted with "A" or "B" Action.

2.14.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.14.3.2 Circuit Breaker With Ground-Fault Circuit Interrupter

UL 943 and NFPA 70. Provide with auto-monitoring (self-test) and lockout features, "push-to-test" button, visible indication of tripped condition, and ability to detect and trip when current imbalance is 6 milliamperes or higher per requirements of UL 943 for Class A ground-fault circuit

interrupter devices.

2.14.3.3 Arc-Fault Circuit Interrupters

UL 489, UL 1699 and NFPA 70. Molded case circuit breakers: rated as indicated. Two pole arc-fault circuit-interrupters: rated 120/240 volts. The provision of (two) one pole circuit breakers for shared neutral circuits in lieu of (one) two pole circuit breaker is unacceptable. Provide with "push-to-test" button.

2.14.3.4 Solid-State Trip Elements

Solid-state circuit breakers shall be provided at the locations indicated on the EP600 panel schedules. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-state sensing shall measure true RMS current with error less than one percent on systems with distortions through the 13th harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be toroidal construction, encased in a plastic housing filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100 percent continuous duty. Circuit breakers shall have tripping features as shown on the drawings and as described below:

a. Long-time current pick-up, adjustable from 50 percent to 100 percent of continuous current rating.

b. Adjustable long-time delay.

c. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.

d. Adjustable short-time delay.

e. Short-time I square times t switch.

f. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.

g. (At locations indicated on the plans) Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted.

h. (At locations indicated on the plans) Adjustable ground-fault delay.

i. (At locations indicated on the plans) Ground-fault I square times t switch.

j. Overload, Short-circuit, Ground-fault (as applicable) trip indicators shall be provided.

k. Provide circuit breakers with high-instantaneous trip properties where needed to satisfy selective coordination requirements. See Section 26 05 73 POWER SYSTEM STUDIES.

2.14.3.4.1 Circuits Protected by Solid-State (Adjustable) Trip Elements

Circuits protected by solid-state (adjustable) trip elements are shown sized for the value identified on the panel schedules, one-line diagrams, and other elements where circuit sizing is indicated on the plans and account for ampacity correction and adjustment factors. Except where indicated otherwise, all adjustable trip circuit breakers shall be provided with a restricting means described in NFPA 70 Section 240.6(C), and that means shall be a removable and sealable cover (240.6(C)(1)); the others means described in NFPA 70 Section 240.6(C) are not acceptable.

Should the solid-state (adjustable) circuit breaker not be restricted by a means described in NFPA 70 Section 240.6(C) and the trip element is capable of a rating greater than the value identified in the diagram and schedules described above, the contractor is responsible for changing the conductor and raceway size(s) at no additional cost to the government to satisfy NFPA 70 Section 240.6(B), and shall account for all correction and adjustment factors stated in NFPA 70 and UFC 3-520-01 and to maintain compliance with the voltage drop requirements of ASHRAE 90.1 and UFC 3-501-01 for the proportional load increase relative to the original circuit breaker rating indicated on the plans. The contractor shall submit such changes for government approval as Adjustable-Trip Circuit Breaker Circuit Corrections. This shall include circuits whose protection is on the load end of the conductors (such as transformer secondary conductors). Bonding jumpers and equipment grounding conductors shall likewise be adjusted.

Where restricted by a means described in NFPA 70 Section 240.6(C) and the trip element is capable of a rating greater than the value identified in the diagram and schedules described above, provide a label for the circuit breaker indicating the conductors are sized to an adjusted trip rating below the maximum capable by the trip element and state the rating to which the conductors are sized.

Electronic circuit breakers may be used in other applications at the contractor's discretion (i.e., utilizing a larger frame with a smaller plug trip rating in order to land larger conductors on the terminals).

2.14.3.4.2 Adjustable Circuit Breaker Settings Cover

All adjustable circuit breakers shall be provided with a removable sealable cover over the adjusting means in accordance with NFPA 70. Covers shall be sized appropriately for each circuit breaker to enclose all adjustable breaker trip settings without interfering with normal breaker operability. Cover shall be of transparent plastic which allows for unobstructed visibility of breaker settings while restricting physical access to the adjusting means. Cover shall be sealable by means of screws, bolts, or other approved locking means.

2.14.3.5 Maintenance Switch

Where a solid-state circuit breaker is rated for or can be adjusted to 800 amperes or higher, the device shall be provided with an auxiliary two-position arc energy-reducing maintenance switching with local status indicator. Positions shall be labeled "NORMAL OPERATION" and "MAINTENANCE". "NORMAL OPERATION" shall provide the protection settings identified by and approved in the protective coordination study. "MAINTENANCE" shall change the instantaneous and short-time current

pick-up settings to the lowest values permitted by the device.

2.14.3.6 Circuit Breaker Handle Locks and Lock-out Device

All circuit breakers supplying fire alarm circuits, or as otherwise indicated in the drawings, shall be provided with handle locks capable of securing the circuit breaker in the On or Off position. Handle locks intended as lock-on devices for circuit breakers feeding fire alarm circuits shall be non-padlock, screw type devices. Lock-out devices intended to secure circuit breakers in the Off position shall be padlockable. Handle locks and lock-out devices shall be sized appropriately for each circuit breaker they are intended to be secured to.

2.14.3.7 Enclosed Circuit Breakers

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated. Provide solid neutral unless otherwise noted.

Similar to the Circuit Breakers submittal, specific specialty type enclosed circuit breakers found on the plans and schedules (or appurtenances used for the satisfaction of said requirements) shall be included in the Enclosed Circuit Breakers submittal.

2.15 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors, also called motor circuit protectors (MCPs): UL 508 and UL 489, and provided as shown. Provide MSCPs that consist of an adjustable instantaneous trip circuit breaker used only in conjunction with a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection. Rate MSCPs in accordance with the requirements of NFPA 70.

2.16 TRANSFORMERS

2.16.1 Low- to Low-Voltage Transformers

Provide transformers in accordance with the following:

a. NEMA ST 20, general purpose, dry-type, self-cooled, ventilated, except sealed where indicated to be NEMA 4.

b. Provide transformers in NEMA enclosure rating as indicated on the transformer schedule.

c. Taps for transformers 15 kVA and larger: Two 2.5 percent taps Full Capacity Above Nominal (FCAN) and four 2.5 percent taps Full Capacity Below Nominal (FCBN) .

d. Transformer insulation system:

(1) 220 degrees C insulation system for transformers 15 kVA and greater, with temperature rise not exceeding 115 degrees C under full-rated load in maximum ambient of 40 degrees C.

(2) 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 80 degrees C under full-rated load in maximum ambient of 40 degrees C.

e. Transformer of 150 degrees C temperature rise is not acceptable.

f. Transformer of 115 degrees C temperature rise: capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.

g. Transformer of 80 degrees C temperature rise: capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.

h. Manufacturer transformer inrush data shall be available and provided for use under Section 26 05 73 COORDINATED POWER SYSTEM PROTECTION WITH ARC FLASH HAZARD STUDY.

i. See Sheet EP600 regarding requirements completely enclosed transformers in accordance with NFPA 70 Section 450.21(B) Exception #2 for specific transformer(s).

2.16.1.1 Specified Transformer Efficiency

Transformers, indicated and specified with: 480V primary, 80 degrees C or 115 degrees C temperature rise, kVA ratings of 37.5 to 100 for single phase or 30 to 500 for three phase, energy efficient type. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in 10 CFR 431, Subpart K.

2.16.1.2 Transformers With Non-Linear Loads

Provide transformers for non-linear loads in accordance with the following:

a. Transformer insulation: UL recognized 220 degrees C system. Neither the primary nor the secondary temperature is allowed to exceed 220 degrees C at any point in the coils while carrying their full rating of non-sinusoidal load.

b. Transformers are to be UL listed and labeled for K-Factor rating as indicated in accordance with UL 1561.

c. Transformers evaluated by the UL K-Factor evaluation: listed for not greater than 115 degrees C average temperature rise only.

d. Transformers with K-Factor ratings with temperature rise of 150 degrees C rise are not acceptable.

e. K-Factor rated transformers impedance: allowed range of 3 percent to 5 percent, with a minimum reactance of 2 percent to prevent excessive neutral current when supplying loads with large amounts of third harmonic.

2.16.2 Medium- to Low-Voltage Transformers

IEEE C57.12.01, and IEEE C57.12.51 for dry-type transformers rated 501 kVA and larger. Transformer base must be fabricated of type 304 or 304L stainless steel. Transformer base must include any part of the transformer that is within 3 inches of concrete pad. Windings must be copper.

Provide a vacuum pressure impregnated (VPI) type transformer with an

insulation system rated 220 degrees C, and with an 80 degree C average winding temperature rise above a 40 degrees C maximum ambient.

2.16.2.1 Transformer Ratings

Transformer must be rated 95 kV BIL Primary and 10 kV BIL Secondary, with KVA as indicated.

a. Transformer voltage ratings: As indicated.

b. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Locate tap adjustments on the face of the high voltage coil. Adjustments must be accessible by removing the front panel and must be made when the transformer is de-energized.

c. Audible sound levels must comply with the following:

kVA	DECIBELS (MAX)
750	64

d. Diagrammatic stainless steel or laser-etched anodized aluminum nameplate.

e. Transformer must include ground pads, lifting lugs and provisions for jacking under base. See S-### series sheets for pad details. The transformer base construction must be suitable for using rollers or skidding in any direction. The transformer must have an insulated low-voltage neutral bushing with lugs for ground cable, and with removable ground strap.

f. Dry type transformer must have the following accessories.

g. Winding temperature indicator

2.17 MOTORS

Provide motors in accordance with the following:

a. NEMA MG 1 except provide fire pump motors as specified in Section 21 30 00 FIRE PUMPS.

b. Hermetic-type sealed motor compressors: Also comply with UL 984.

c. Provide the size in terms of HP, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified.

d. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters.

e. Rate motors for operation on 208-volt, 3-phase circuits with a terminal voltage rating of 200 volts, and those for operation on 480-volt, 3-phase circuits with a terminal voltage rating of 460 volts.

f. Use motors designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating.

g. Unless otherwise indicated, use continuous duty type motors if rated 1

HP and above.

h. Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

i. Use Inverter-Rated motors designed to operate with adjustable speed drive (ASD).

2.17.1 High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors: high efficiency types are not acceptable. In exception, for special purpose motors and motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.17.2 Premium Efficiency Polyphase and Single-Phase Motors

Select polyphase and continuous-duty single phase motors based on high efficiency characteristics relative to typical characteristics and applications as listed in NEMA MG 10 and NEMA MG 11. In addition, continuous rated, polyphase squirrel-cage medium induction motors must meet the requirements for premium efficiency electric motors in accordance with NEMA MG 1, including the NEMA full load efficiency ratings. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.17.3 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

2.17.4 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment using adjustable speed drive (ASD) manufacturer required wiring type and length, (where applicable)and motor control equipment forming part of motor control centers or switchgear assemblies, the conduit and wiring connecting such centers, assemblies, or other power sources to equipment as specified herein. Power wiring and conduit: conform to the requirements specified herein. Control wiring: provided under, and conform to, the requirements of the section specifying the associated equipment.

2.18 MOTOR CONTROLLERS

Provide motor controllers in accordance with the following:

a. UL 508, NEMA ICS 1, and NEMA ICS 2, except fire pump controllers as specified in Section 21 30 00 FIRE PUMPS.

b. Provide controllers with thermal overload protection in each phase, and one spare normally open auxiliary contact, and one spare normally closed auxiliary contact.

c. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage.

d. Provide protection for motors from immediate restart by a time adjustable restart relay.

e. When used with pressure, float, or similar automatic-type or maintained-contact switch, provide a hand/off/automatic selector switch with the controller.

f. Connections to selector switch: wired such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position.

g. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices: connected in motor control circuit in "hand" and "automatic" positions.

h. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device: made in accordance with indicated or manufacturer's approved wiring diagram.

i. Provide selector switch with the means for locking in any position.

j. Provide a disconnecting means, capable of being locked in the open position, for the motor that is located in sight from the motor location and the driven machinery location. As an alternative, provide a motor controller disconnect, capable of being locked in the open position, to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

k. Overload protective devices: provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case.

l. Cover of combination motor controller and manual switch or circuit breaker: interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position.

m. Minimum short circuit withstand rating of combination motor controller: shall be the rating of the supply panelboard/switchboard.

n. Provide controllers in hazardous locations with classifications as indicated on the E-### series sheets.

Controller sizes identified on plans are minimum sizes, and the contractor is responsible for increasing sizes to account for increased current drawn based on requirements of contractor-furnished equipment and/or for termination compatibility with conductor sizes increased due to voltage drop mitigation requirements and/or conductor ampacity

corrections/adjustments for the ambient temperature or number of current-carrying conductors. (Additionally, see Subparts "Conductor Termination Adapters" and "CFCI Equipment Electrical Data")

2.18.1 Control Wiring

Provide control wiring in accordance with the following:

a. All control wire: stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and passing the VW-1 flame tests included in those standards.

b. Hinge wire: Class K stranding.

c. Current transformer secondary leads: not smaller than No. 10 AWG.

d. Control wire minimum size: No. 14 AWG.

e. Power wiring for 480-volt circuits and below: the same type as control wiring with No. 12 AWG minimum size.

f. Provide wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.18.2 Control Circuit Terminal Blocks

Provide control circuit terminal blocks in accordance with the following:

a. NEMA ICS 4.

b. Control circuit terminal blocks for control wiring: molded or fabricated type with barriers, rated not less than 600 volts.

c. Provide terminals with removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts.

d. Terminals: not less than No. 10 in size with sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal.

e. Terminal arrangement: subject to the approval of the Contracting Officer with not less than four spare terminals or 10 percent, whichever is greater, provided on each block or group of blocks.

f. Modular, pull apart, terminal blocks are acceptable provided they are of the channel or rail-mounted type.

g. Submit data showing that any proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.18.2.1 Types of Terminal Blocks

a. Short-Circuiting Type: Short-circuiting type terminal blocks: furnished for all current transformer secondary leads with provision for shorting together all leads from each current transformer without

first opening any circuit. Terminal blocks: comply with the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity: provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. Provide terminals of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, provide screws with hexagonal heads. Conducting parts between connected terminals must have adequate contact surface and cross-section to operate without overheating. Provide each connected terminal with the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.18.3 Control Circuits

Control circuits: maximum voltage of 120 volts derived from control transformer in same enclosure. Transformers: conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits: provide primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on primary side. Provide one fused secondary lead with the other lead grounded.

2.18.4 Enclosures for Motor Controllers

NEMA ICS 6.

2.18.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers: include compelling relays and multiple-button, station-type with pilot lights for each speed.

2.18.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations: heavy duty, oil-tight design.

2.18.7 Pilot and Indicating Lights

Provide LED cluster lamps.

2.19 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

SingleDoubleThree pole designed for flush mounting with overload protection and pilot lights.

2.19.1 Pilot Lights

Provide yoke-mounted, seven element LED cluster light module. Color: in accordance with NEMA ICS 2.

2.20 LOCKOUT REQUIREMENTS

Provide circuit breakers, disconnecting means, and other devices that are electrical energy-isolating capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147, NFPA 70E and 29 CFR 1910.303. Comply with requirements of Division 23, "Mechanical" for mechanical isolation of machines and other equipment.

2.21 TELECOMMUNICATIONS SYSTEM

Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires and other accessories for telecommunications outlets and pathway in accordance with TIA-569 and as specified herein. Additional telecommunications requirements are specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.21.1 Backboards

Provide void-free, fire rated interior grade plywood, 3/4 inch thick, 4 by 8 feet. Do not cover the fire stamp on the backboard. Coordinate backboard requirements with telecommunications backboard requirements as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING.

2.22 GROUNDING AND BONDING EQUIPMENT

2.22.1 Ground Rods

UL 467. Ground rods: cone pointed copper-clad steel, with minimum diameter of 3/4 inch and minimum length 10 feet. Sectional type rods may be used for rods 20 feet or longer.

2.22.2 Ground Bus

Copper ground bus: provided in the electrical rooms as indicated on the plans.

2.22.3 Secondary Bonding Busbar

Provide corrosion-resistant grounding busbar suitable for indoor installation in accordance with TIA-607. Busbars: plated for reduced contact resistance. If not plated, clean the busbar prior to fastening the conductors to the busbar and apply an anti-oxidant to the contact area to control corrosion and reduce contact resistance. Provide a Primary bonding busbar (TGB) in the telecommunications entrance facility. The Primary bonding busbar (TGB) sized in accordance with the immediate application requirements and with consideration of future growth. Provide Primary bonding busbars with the following:

a. Predrilled copper busbar provided with holes for use with standard sized lugs,

b. Minimum dimensions of 0.25 in thick by 4 in wide for the TGB with length as indicated;

c. Listed by a nationally recognized testing laboratory.

2.23 HAZARDOUS LOCATIONS

Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70: specifically approved by Underwriters' Laboratories, Inc., or Factory Mutual for particular "Class," "Division," and "Group" of hazardous locations involved. Boundaries and classifications of hazardous locations: as indicated. Equipment in hazardous locations: comply with UL 1203 for electrical equipment, UL 877 for circuit breakers, UL 886 for outlet boxes and fittings, UL 1010 for receptacles, UL 698A for industrial controls, and UL 674 for motors.

2.24 MANUFACTURER'S NAMEPLATE

Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.25 FIELD FABRICATED NAMEPLATES

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 0.125 inch thick, white with black center core.

e. Provide red laminated plastic label with white center core where indicated.

f. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

g. Minimum size of nameplates: one by 2.5 inches.

h. Lettering size and style: a minimum of 0.25 inch high normal block style.

2.26 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.27 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00 FIRESTOPPING.

2.28 WIREWAYS

UL 870. Material: steel galvanized 16 gauge for heights and depths up to 6 by 6 inches, and 14 gauge for heights and depths up to 12 by 12 inches. Provide in length required for the application with screw - cover NEMA appropriate for application (match ratings of area equipment) enclosure per NEMA ICS 6.

2.29 METERING

Reference Section 26 24 13, SWITCHBOARDS. Metering requirements from Section 26 24 13, SWITCHBOARDS shall also apply to service-entrance panelboard(s). ANSI C12.1.

2.30 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service entrance, panelboards, and switchboards where indicated on the EP600 series one-line diagram and panel schedules, and as indicated elsewhere in the contract drawings and specifications; this shall include both distribution equipment surge protective devices (where required at panelboards, distribution panels, switchboards, switchgear, etc.) and branch circuit surge protective devices. Provide surge protectors in an enclosure matching the NEMA ICS 6 rating identified for the protected equipment (See EP620 series panel schedules). SPD must have the same short-circuit current rating as the protected equipment and must not be installed at a point of system where the available fault current is in excess of that rating. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker unless otherwise indicated; use of a fuse in lieu of circuit breaker is not acceptable. Do not install SPD inside a panel enclosure. The maximum lead length permitted is 3'. Submit performance and characteristic curves. Provide Form C dry contacts for remote monitoring, and indicate to the reporting system when the unit has malfunctioned and/or requires replacement (SPDs shall be provided with local visual indicators for the same diagnostics; UFC 3-520-01 Sections 3-4.1.1 and 3-4.1.2). SPD submittals shall include the manufacturer's recommended overcurrent protective device rating for the device(s) to be installed, and the circuit breaker ratings and conductor sizes shall be adjusted accordingly at no additional cost to the government.

Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
- Phase to phase (L-L)
- Each phase to neutral (L-N)
- Neutral to ground (N-G)
- Phase to ground (L-G)

FOR DELTA CONNECTIONS-
- Phase to phase (L-L)
- Phase to ground (L-G)

SPDs at the service entrance: provide with a minimum surge current rating of 80,000 amperes for L-L mode minimum and 40,000 amperes for other modes

(L-N, L-G, and N-G) and downstream SPDs rated 40,000 amperes for L-L mode minimum and 20,000 amperes for other modes (L-N, L-G, and N-G).

Provide SPDs per NFPA 780 for the lightning protection system.

Maximum L-N, and N-G Voltage Protection Rating:

600V for 120V, single phase system
1,000V for 120/240V, single phase system
600V for 120/240V, three phase system
600V for 208Y/120V, three phase system
1,200V for 480Y/277V, three phase system

Maximum L-G Protection Rating:
700V for 120V, single phase system
1,000V for 120/240V, single phase system
700V for 120/240V, three phase system
700V for 208Y/120V, three phase system
1,200V for 480Y/277V, three phase system

Maximum L-L Voltage Protection Rating:

1,200V for 120/240V, three phase system
1,200V for 208Y/120V, three phase system
1,800V for 480Y/277V, three phase system

The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120 percent of nominal voltage for 240 volts and below; 115 percent of nominal voltage above 240 volts to 480 volts.

Provide EMI/RFI filtering per UL 1283 for each mode with the capability to attenuate high frequency noise. Minimum attenuation: 20db.

2.31 FACTORY APPLIED FINISH

Provide factory-applied finish on electrical equipment in accordance with the following:

a. NEMA 250 corrosion-resistance test and the additional requirements as specified herein.

b. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.

c. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.

d. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.

e. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.

f. Equipment located indoors: ANSI Light Gray, and equipment located outdoors: ANSI Light Gray.

g. Provide manufacturer's coatings for touch-up work and as specified in

paragraph FIELD APPLIED PAINTING.

2.32 SOURCE QUALITY CONTROL

2.32.1 Transformer Factory Tests

2.32.1.1 Low- to Low-Voltage Transformer Factory Tests

Include routine NEMA ST 20 transformer test results on each transformer and also provide the results of NEMA "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

2.32.1.2 Medium- to Low-Voltage Transformer Factory Tests

2.32.1.2.1 Design Tests

In accordance with IEEE C57.12.01 and IEEE C57.12.91. Additionally, IEEE C57.12.80 Section 5.1.2 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports in the same submittal package as the product data, shop drawings, and certificates of transformer losses for each of the specified transformers. Design tests must have been performed prior to the award of this contract.

Provide required submittals with index and tabs.

a. Tests must be certified and signed by a registered professional engineer. Engineers stamp and signature must appear on at least the first page of the factory test reports.

b. Temperature rise: "Basically the same design" for the temperature rise test means a transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type, the same temperature rise rating, the same insulating class and the same insulating medium as the transformer specified.

   Provide temperature rise readings, formulas, calculations of average temperature rise, and description of test method.

c. Lightning impulse: Basically the same design" for the lightning impulse dielectric test means a transformer with the same BIL and the same coil construction.

   (1) IEEE C57.12.91 and IEEE C57.98. Provide design lightning impulse tests consisting of a reduced full-wave, two-chopped waves, and one full wave test for each phase of the primary and secondary windings of the same transformer.

   (2) State test voltage levels.

d. Partial Discharge Test per IEEE C57.124. Provide transformer ratings, description and diagram of test method used, test readings and final results.

Routine and Other Tests

In accordance with IEEE C57.12.01 and IEEE C57.12.91. Routine and other tests must be performed by the manufacturer on each of the actual

transformers prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence must be as follows:

e. Resistance measurements

f. Phase relation

g. Ratio

h. Insulation power-factor by manufacturer's recommended test method

i. No-load losses (NLL) and excitation current

j. Load losses (LL) and impedance voltage

k. Lightning impulse: Perform the complete design type impulse tests on the transformer primary winding only.

(1) IEEE C57.12.91 and IEEE C57.98

(2) State test voltage levels

(3) Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test reports.

l. Low frequency dielectric

m. Applied voltage

n. Induced voltage

2.33 Conductor Termination Adapters

Pin adapters, reducers, lug kit adapters, pigtail adapters, and similar devices may be used for reduction from conductor size(s) larger than size(s) acceptable by terminals on equipment satisfying all other contract requirements.

Devices must be listed and compatible with the material with which interface occurs (i.e., copper conductors, aluminum busbars, etc.). Devices must not result in modification of equipment in or on which they are installed which results in compromise of the listing of the equipment nor of the manufacturer(s) warranty.

Products must be UL 486A-486B listed.

Crimp, compression, or mechanical/torque type adapters are permitted.

Adapters provided for insulated conductors (other than grounding electrode conductors, bonding jumpers, and equipment bonding conductors) shall be provided with an insulating cover. Adapters provided for bare conductors (and for grounding electrode conductors, bonding jumpers, and equipment bonding conductors) may omit an insulating cover.

Adapters must not be used to reduce conductor sizes below the maximum size permitted by the equipment, circuit breaker, etc., terminations in question requiring the adapters. Conductors must not be reduced in size

smaller than required by ambient temperature and current-carrying conductor ampacity corrections and adjustments; utilize increased conductor insulation temperature rating as necessary.

2.34 Documentation of Terminations

All submittals for distribution equipment and disconnecting means on which conductors terminate (to include transformers, panelboards, switchboards, switchgear, variable frequency drives, enclosed circuit breakers, starters, disconnect switches, and similar) shall include conductor termination information to validate the suitability of equipment provided against the conductors required to satisfy voltage drop and ampacity adjustment/correction requirements.

2.35 Electrical System Accounting for Contractor-Furnished/Contractor-Installed (CFCI) Equipment and Devices:

While the Federal Acquisition Regulation (FAR) and Defense Federal Acquisition Regulation Supplement (DFARS) requirements prohibit the use of branch name (or equal) references in solicitations without a Justification and Approval for sole source procurement, equipment connection electrical properties (voltage, phase, amps, protection) included on the “Equipment Electrical Connection Schedule” are based on products available at the time of design and have been incorporated into the electrical distribution system included in the contract documents. The contractor must select equipment matching the electrical properties to the extent a deviation is not required for the sizes and configurations of the supply circuits and distribution equipment. Should any deviations be required, such changes (including but not limited to conductor quantities, conductor sizes, protection size, protection poles, disconnect size, disconnect type, disconnect poles, supply equipment (panelboard, switchboard, switchgear, transformer) rating, and reperformance of power studies) shall be at no additional cost to the government, and any submittals approved which are impacted by such deviations must be re-submitted for approval incorporating the changes required to account for the deviations from the design conditions.

Equipment phase balancing of the load must be maintained to no greater than 5% imbalance while observing destination and routing grouping of circuits on the panelboards represented on the contact document panel schedules; exceptions to the 5% imbalance will be limited to lightly loaded or low circuit quantity panelboards (namely where already demonstrated in the contract documents to not satisfy this requirement) and instances where not practical from a circuit organization perspective (for example, see circuit organization on the panelboard(s) dedicated to telecommunication circuits) but maintaining an aggregated phase balance at upstream busses. Adjustments must maintain the spare space requirements, spare capacity requirements, conductor ampacity requirements, and voltage drop limits identified in UFCs 3-501-01 and 3-520-01, and shall re-account for fault contributions in the final establishment of withstand and interrupt ratings (and in turn, arc flash calculations and labeling).

This subpart is applicable to all electrical installation in the contract and not limited to the products listed in this individual specification section.

2.35.1 CFCI Equipment Electrical Data

Submit in tabular form all contractor-furnished/contractor-installed

equipment requiring power connections shall be submitted at the same time as the supply equipment submittals and shall include the following:

(1) Equipment identifier on electrical plans
(2) Equipment type
(3) Approved Submittal Number (eg, 23 81 00.00 20-# for unitary air conditioning equipment)
(4) Manufacturer
(5) Model and Catalog Number
(6) Voltage
(7) Phase(s)
(8) Full-Load Amps (FLA)
(9) Minimum Circuit Ampacity (MCA)
(10) Manufacturer-Recommended Overcurrent Protection Device (MOCP)
(11) Minimum Disconnect Size

Inclusion of unapproved equipment will result in rejection of the CFCI and supply equipment submittals.

Identify in CFCI Equipment Electrical Data equipment with voltage, phase, FLA, MCA, and MOCP characteristics differing from the contract documents.

For CFCI equipment with multiple load components from a single building feed (for example: bridge cranes), provide the above data for the entire assembly with respect to the circuit supplied by the building (in addition to the protective elements for the individual components for the respective equipment's schematic diagram submittals).

Include equipment operating on 24V or similar characteristics utilizing step-down transformers local to the equipment but connected to the building distribution system. Items whose power is supplied from a control panel where the voltage is reduced below the aforementioned threshold need not be included, but the control panel interfacing with the electrical distribution system shall be included.

Include Surge Protective Devices (even though they have no load) in CFCI Equipment Electrical Data to track the MOCP and corresponding conductor requirements should they differ from the values assumed in the contract documents.

Include Adjustable Speed/Variable Frequency Drives in CFCI Equipment Electrical Data to track circuit characteristics which may require adjustment in accordance with NFPA 70 Article 430 Part X.

Devices and equipment requiring building electrical distribution interface must adhere to the electrical configurations (phase/poles, voltage, etc.) identified by instance on the electrical plans and schedules.

Electrical System Contractor Variances for equipment shall be furnished at the time the Product Data is submitted and shall be comprehensive of all equipment seeking variance. Purchase and/or installation of equipment requiring an electrical variance prior to variance approval shall be at the risk to the contractor. Request for variance shall not assume approval of such variance. The electrical system connections have been coordinated with the basis of design equipment shown on the architectural, interior design, fire protection, plumbing, mechanical, and/or electrical drawings. Should the equipment submitted for approval vary from the design equipment electrical needs and require a different connection than shown on the electrical plans, the contractor shall submit for approval

revised schedules, plans, and diagrams indicating the changes to the electrical system due to the equipment variance based on the manufacturer-recommended minimum circuit ampacity (MCA) and maximum overcurrent protection (MOCP). The DOR reserves the right to increase conductor sizes above the manufacturer-required MCA due to ASHRAE 90.1 voltage drop and NFPA 70 derating/correction factors.

Circuit breakers shall be coordinated with deviation required by variances from the characteristics used in design as described in other specification sections and EP sheets. Where deviations are necessary, government approval is required. Deviations will be evaluated on the basis of load balancing by phase, maintaining spacial proximity, and system and equipment assignment; change in the votage will not be acceptable except in rare circumstances. Request for variance shall indicate the originating and final locations of all transplanted circuit breakers and the associated load names. Finally, circuit breakers for equipment requiring submission for approval are subject to change based on the manufacturer's MOCP of the submitted equipment, and the manufacturer's MOCP value shall be the value used for the protection device rating incorporated into related electrical protection device/equipment submittals and the installed condition. Incorporation of the final circuit breaker sizes into the distribution equipment is the responsibility of the contractor and are subject to approval through the submittal process. Circuit breaker sizes in the design documents shall not be assumed to be final for equipment provided in this contract and do not override the manufacturer's recommendations.

All equipment and devices must be properly rated for installation in the available fault current environment which exists at the location the equipment is installed. The contractor shall provide supplemental equipment features or fault current reduction measures where furnished equipment has a SCCR value less than the vault current available at the installed location where needed to satisfy this requirement.

Equipment and devices supporting CFCI equipment may be submitted for basic contract compliance review, but not for approval for installed equipment suitability without the associated data described herein.

2.35.2 Interim CFCI Equipment Electrical Data

The information required by the "CFCI Equipment Electrical Data" submittal may be furnished on an interim basis for inclusion of the partial set of the final data to support approval of related electrical distribution equipment (such as the data associated with a specific panelboard or set of panelboards). The data provided must be complete for the items included, to include identification of the submittal approving the equipment without a re-submittal required (that is, the submittal has received an "A" or "B" Action).

This item in the submittal registry is representative of any number of submittals the contractor wishes to produce for the purpose described in the preceding paragraph, and additional submittal registry entries may be created with unique names to facilitate the review and approval needs throughout the project life cycle prior to the approval of the comprehensive set of CFCI Equipment Electrical Data.

The following may be used for parts of the distribution system to facilitate equipment approval:

Interim CFCI Equipment Electrical Data (Fire Alarm)
For all equipment supplied by Section 28 31 70 Item: "Dedicated Emergency Panel Schedules".

Interim CFCI Equipment Electrical Data (Generator Station Service)
For all equipment supplied by panels GA1, GA2, GB1, and GB2 for generator loads requiring building power.

Interim CFCI Equipment Electrical Data (Filter Shelter)
For all equipment supplied by distribution equipment at the Filter Shelter (See EP604S, EP614S, EP632S, EP633S, and EP634S).

Interim CFCI Equipment Electrical Data (Offload)
For all equipment supplied by distribution equipment at the pumped offload (outside the Restricted Area fence; see EP603, EP613, EP631).

2.36 COORDINATED POWER SYSTEM PROTECTION

Prepare analyses as specified in Section 26 05 73 POWER SYSTEM STUDIES.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces: conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

3.1.1 Underground Service

Underground service conductors and associated conduit: continuous from service entrance equipment to outdoor power system connection.

Encase the underground portion of the conduit in a concrete envelope and bury as specified for underground duct with concrete encasement.

3.1.2 Hazardous Locations

Perform work in hazardous locations, as defined by NFPA 70, in strict accordance with NFPA 70 for particular "Class," "Division," and "Group" of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Provide conduit with tapered threads. Reference E-### series sheets for extent of hazardous area. Conductor and conduit sizes indicated on plans shall be considered minimum sizes.

3.1.2.1 Sealoffs

All conduits have been sized based on maximum 40 percent fill ratios and shall be considered minimum sizes. Provide sealoffs specifically identified and rated for 40 percent fill in accordance with the permission stated in NFPA 70 Section 501.15(C)(6). Sealoffs shall be inspectable and accessible.

3.1.3 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures: labeled and identified as such.

3.1.3.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum: indicate number of service disconnect devices housed by enclosure and indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure: provided only as permitted by NFPA 70.

3.1.4 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor: separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Shared neutral, or multi-wire branch circuits, are not permitted with arc-fault circuit interrupters. Minimum conduit size: 1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings: made with metal conduit in fire-rated shafts, with metal conduit extending through shafts for minimum distance of 6 inches. Firestop conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors in accordance with Section 07 84 00 FIRESTOPPING.

3.1.4.1 Prohibition on Shared Raceways for Circuits Supplied from Generator

Per UFC 3-540-01 Section 2-5.1, wiring from the generator to the loads served shall be kept entirely independent of all other general wiring unless otherwise permitted in NFPA 70 Article 700.

3.1.4.2 Pull Wire

Install pull wires in empty conduits. Pull wire: plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

3.1.4.3 Metal-Clad Cable

Install in accordance with NFPA 70, Type MC cable.

3.1.5 Adjustments for Unique Conductor Termination Applications

Note the equipment frame ratings on plans are identified in the schedule key to be minimum ratings, and larger frames (either for equipment or individual circuit breakers) will be required to terminate the conductors significantly increased in size for voltage drop (especially conductors associated with PHA and PHB) in accordance with the acceptable wire size and set ranges established by the manufacturer(s).

For feeders (other than panelboard-mounted circuit breakers for single-motor feeder applications) and service conductors, conductors must terminate without splicing directly on terminations provided by the equipment manufacturers or using a product described in Subpart "Conductor Termination Adapters." This shall also apply to terminations at

disconnect switches, starters, combination starter/disconnects, and enclosed circuit breakers. Splices for the purpose of wire size reduction to land conductors on equipemnt terminations or adapters described are not acceptable.

For branch circuits and panelboard-mounted circuit breakers for single-motor feeder applications where adapters will not fit on devices at the point of termination, the total length of conductor to be reduced below the size adjusted to mitigate voltage drop must not exceed 10 feet or 10 percent of the circuit length, whichever is less. Provide the sizing information on the equipment directory (and O&M manual, where applicable) indicating differing conductor sizes along the circuit.

For conductors represented on the power studies where splices occur to reduce conductor sizes to land on terminations, model this size change accordingly in the power studies.

In applications where 200% neutral bus is indicated, if the equipment supplier needs to provide larger phase lugs and the new 100% bus would satisfy the original 200% bus, the new equipment does not need a 200% neutral as long as the conductors can suitably terminate on the new 100% bus lugs. In other words, provide a neutral bus with termination which will accommodate the conductors. For example, if the plans indicate a 100A mains with 200% neutral but requires conductors (for example: 3-3/0, 350kcmil N) exceeding the 100A mains buses' terminations (thus requiring a 225A or 400A frame), if the neutral conductor can land without reduction on thet 100% neutral bus of a size at least 200% the size of the original bus, the 100% neutral bus is acceptable on the larger equipment frame size.

3.1.6 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Exposed conduit is permissible in the generator bays, utility rooms, and unfinished spaces. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project. Run conduits under floor slab as if exposed; do not install conduits routed horizontally on top of the floor.

Exterior building-mounted devices and equipment shall be wired from within the building and shall conform to the interior wiring standards described in this section to the greatest extent possible. No exterior building-mounted equipment and device circuits shall be surface mounted.

Conduits and associated support elements shall be coordinated with all other trades prior to installation. Installation resulting in interferences shall be resolved at no additional cost to the government. For example, conduits shall not be installed below door openings, including overhead coiling doors.

For entities shown at the roof level or mounted to the building exterior, even though the supporting infrastructure (such as junction boxes and conduits) may be shown on outside the building, the raceways shall be interior to the building except where necessary to exit the building to supply the end devices unless otherwise noted.

See E-### series sheets regarding areas subject to physical damage.

3.1.6.1 Restrictions Applicable to Aluminum Conduit

a. Do not install underground or encase in concrete or masonry.

b. Do not use brass or bronze fittings.

3.1.6.2 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use in hazardous areas.

e. Do not use outdoors or in areas requiring wet ratings (see E-### series sheets).

f. Do not use in fire pump rooms.

g. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.6.3 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40.

(1) Do not use where subject to physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, fire pump rooms, generator rooms, and where restrictions are applying to both PVC Schedule 40 and PVC Schedule 80.

(2) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

b. PVC Schedule 40 and Schedule 80.

(1) Do not use where subject to physical damage.

(2) Do not use in hazardous (classified) areas.

(3) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

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3.1.6.4 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS.

3.1.6.5 Service Entrance Conduit, Underground

PVC, Type-EPC 40, galvanized rigid steel or steel IMC. Underground portion shall be encased in minimum of 3 inches of concrete and shall be installed minimum 18 inches below slab or grade.

3.1.6.6 Underground Conduit

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40. Convert nonmetallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before rising through floor slab. Plastic coating: extend minimum 6 inches above floor.

3.1.6.7 Conduit for Circuits Rated Greater Than 600 Volts

Rigid metal conduit or IMC only.

3.1.6.8 Conduit Installed Under Floor Slabs

Conduit run under floor slab: located a minimum of 12 inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier. Use NECA NEIS 1 Table 2a (Minimum Raceway Spacing) to determine under floor slab conduit spacing unless greater spacing is required elsewhere in this section.

To the greatest extent practical, route power distrubution system feeders underground and avoid routing through underground areas identified as Class I Division 1 (see E-### sheet series for these areas).

3.1.6.9 Conduit Through Floor Slabs

Where conduits rise through floor slabs, do not allow curved portion of bends to be visible above finished slab. Where conduit rises through slab-on grade, seal all electrical penetrations to address radon mitigation and prevent infiltration of air, insects, and vermin.

3.1.6.10 Conduit Installed in Concrete Floor Slabs

Rigid steel; steel IMC; fiberglass, or PVC, Type EPC-40.Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab. Do not stack conduits more than two diameters high with minimum vertical separation of one inches. Space conduits horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends must not be visible above finish slab. Increase slab thickness as necessary to provide minimum one inch cover over conduit. Where embedded conduits cross building expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings must allow horizontal and vertical movement of raceway. Conduit larger than one inch trade size: installed parallel with or at right angles to main reinforcement; when at right angles to reinforcement, install conduit close to one of supports of slab. Where nonmetallic conduit is used, convert raceway to plastic coated rigid steel or plastic coated steel IMC before rising above floor, unless specifically indicated.

3.1.6.11 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.6.12 Conduit Support

Support conduit by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Plastic cable ties are not acceptable. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Provide vibration resistant and shock-resistant fasteners attached to concrete ceiling. Do not cut main reinforcing bars for any holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems: supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Do not share supporting means between electrical raceways and mechanical piping or ducts. Coordinate installation with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Support exposed risers in wire shafts of multistory buildings by U-clamp hangers at each floor level and at 10 foot maximum intervals. Where conduit crosses building expansion joints, provide suitable watertight expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.6.13 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.6.14 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.6.15 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors; and for equipment explicitly indicated on the drawings. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: 1/2 inch diameter. Provide liquid tight flexible nonmetallic conduit in wet and damp locations (see E-### series sheets) and in fire pump rooms for

equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections. Plastic cable ties are not acceptable as a support method.

3.1.6.16 Telecommunications and Signal System Pathway

Install telecommunications pathway in accordance with TIA-569.

Cable trays, conduits, and associated support elements shall be coordinated with all other trades prior to installation. Installation resulting in interferences shall be resolved at no additional cost to the government. For example, cable trays and conduits shall not be installed below door openings, including overhead coiling doors.

a. Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room: installed and cabling length requirements in accordance with TIA-568.1. Size conduits, wireways, and cable trays in accordance with TIA-569 and as indicated.

b. Backbone Pathway: Telecommunication pathways from the telecommunications entrance facility to telecommunications rooms, and, telecommunications equipment rooms (backbone cabling): installed in accordance with TIA-569. Size conduits, wireways, and cable trays for telecommunications risers in accordance with TIA-569 and as indicated.

3.1.6.17 Areas Subject to Severe Physical Damage

See sheet E-120 and E-100S.

3.1.7 Busway Installation

Comply at minimum with NFPA 70. Install busways parallel with or at right angles to ceilings, walls, and structural members. Support busways at 5 foot maximum intervals, and brace to prevent lateral movement. Provide fixed type hinges on risers; spring-type are unacceptable. Provide flanges where busway makes penetrations through walls and floors, and seal to maintain smoke and fire ratings. Provide waterproof curb where busway riser passes through floor. Seal gaps with fire-rated foam and caulk. Provide expansion joints, but only where bus duct crosses building expansion joints. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.8 Cable Tray Installation

Install and ground in accordance with NFPA 70. In addition, install and ground telecommunications cable tray in accordance with TIA-569 and TIA-607. Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Cable tray and tray supports must not partially nor completely obstruct access to the room. Support in accordance with manufacturer recommendations but at not more than 6 foot intervals. Coat contact surfaces of aluminum connections with an antioxidant compound prior to assembly. Adjacent cable tray sections: bonded together by connector plates of an identical type as the cable tray sections. For grounding of cable tray system provide No. 2 AWG bare copper wire throughout cable tray system, and bond to each section, except use No. 1/0 aluminum wire if cable tray is aluminum. Terminate cable trays 10 inches from both sides of smoke and fire partitions. Install conductors run through smoke and fire partitions in 4 inch rigid steel conduits with

grounding bushings, extending 12 inches beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of partitions. Firestop penetrations in accordance with Section 07 84 00, FIRESTOPPING. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.9 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways: cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to the greater height of 7 feet above floors and walkways or the height of "areas subject to physical damage", or when installed in hazardous areas, and when specifically indicated. Boxes in other locations: sheet steel, except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit system. Provide each box with volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls: square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature. Provide access panels in gypsum ceilings to reach junction boxes; coordinate with other trades such that opening provides unimpeded access to device to be maintained (i.e., opening is not directly below ductwork or cable tray).Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.9.1 Boxes

Boxes for use with raceway systems: minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet. Telecommunications outlets: a minimum of 4 11/16 inches square by 2 1/8 inches deep, except for wall-mounted telephones (see Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS). Mount outlet boxes flush in finished walls in finished spaces.

3.1.9.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 of code-gauge aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders

to indicate clearly electrical characteristics, circuit numbers, and panel designations.

3.1.9.3 Extension Rings

Extension rings are not permitted for new construction.

3.1.10 Mounting Heights

Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of center of grip of the operating handle of the switch or circuit breaker at its highest position is maximum 79 inches above floor or working platform or as allowed in Section 404.8 per NFPA 70. Mount lighting switches, receptacles, telecommunications outlets, and other devices as indicated on mounting height detail sheet.

3.1.11 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with Division 23 Specification Sections. Provide telecommunications system conductor identification as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS.

3.1.11.1 Marking Strips

Provide marking strips for identification of power distribution, control, data, and communications cables in accordance with the following:

a. Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.

b. Use permanent ink for the wire numbers

c. Provide reversible marking strips to permit marking both sides, or provide two marking strips with each block.

d. Size marking strips to accommodate the two sets of wire numbers.

e. Assign a device designation in accordance with NEMA ICS 1 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.

f. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Government's wire designations.

g. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.12 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.12.1 Splices of Aluminum Conductors

Make with solderless circumferential compression-type, aluminum-bodied connectors UL listed for AL/CU. Remove surface oxides from aluminum conductors by wire brushing and immediately apply oxide-inhibiting joint compound and insert in connector. After joint is made, wipe away excess joint compound, and insulate splice.

3.1.13 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.14 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.15 Grounding and Bonding

Provide in accordance with NFPA 70 and NFPA 780. Ground exposed, non-current-carrying metallic parts of electrical equipment, access flooring support system, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, underground storage tanks and pipelines (see Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS), and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70. Make ground connection to driven ground rods on exterior of building. Bond additional driven rods together with a minimum of 4 AWG soft bare copper wire buried to a depth of at least 12 inches. Interconnect all grounding media in or on the structure to provide a common ground potential. This includes lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Make interconnection to the gas line on the customer's side of the meter. Reference EG600 for minimum conductor sizing requirements. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system.

In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA-607. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.15.1 Ground Rods

Provide ground rods and measure the resistance to ground using the fall-of-potential method described in IEEE 81. Do not exceed 25 ohms under normally dry conditions for the maximum resistance of a driven ground. If this resistance cannot be obtained with a single rod, additional rods, spaced on center. Spacing for additional rods must be a minimum of 10 feet. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.15.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, excepting specifically those connections for which access for periodic testing is required, by exothermic weld or high compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make high compression connections using a hydraulic or electric compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.15.3 Ground Bus

Provide a copper ground bus in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of transformer neutrals and other electrical equipment: effectively grounded by bonding to the ground bus. Bond the ground bus to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Make connections and splices of the brazed, welded, bolted, or pressure-connector type, except use pressure connectors or bolted connections for connections to removable equipment.

3.1.15.4 Resistance

Maximum resistance-to-ground of grounding system: do not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Contracting Officer for further instructions.

3.1.15.5 Telecommunications System

Provide telecommunications grounding in accordance with the following:

a. Telecommunications Grounding Busbars: Provide a Primary bonding busbar (TGB) in the telecommunications entrance facility. Install the TGB as close to the electrical service entrance grounding connection as practicable. .

1. Connectors: Mechanical type, cast silicon bronze, solderless

compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.

3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

b. Telecommunications Bonding Conductors: Provide main telecommunications service equipment ground consisting of separate bonding conductor for telecommunications, between the TGB and readily accessible grounding connection of the electrical service. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet in length, bond the conductors to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.

c. Telecommunications Grounding Connections: Telecommunications grounding connections to the TGB: utilize listed compression two-hole lugs, exothermic welding, suitable and equivalent one hole non-twisting lugs, or other irreversible compression type connections. Bond all metallic pathways, cabinets, and racks for telecommunications cabling and interconnecting hardware located within the same room or space as the TGB to the TGB. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; bond each TGB to the vertical steel metal frame using a minimum No. 6 AWG conductor. Where the metal frame is external to the room and readily accessible, bond the metal frame to the TGB with a minimum No. 6 AWG conductor. When practicable because of shorter distances and, where horizontal steel members are permanently electrically bonded to vertical column members, the TGB may be bonded to these horizontal members in lieu of the vertical column members. All connectors used for bonding to the metal frame of a building must be listed for the intended purpose.

d. Comply with TIA-607.

3.1.16 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

3.1.17 Government-Furnished Equipment

Contractor rough-in for Government-furnished equipment make connections to Government-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings; except the contractor shall make final connections to Government-furnished systems furniture.

3.1.18 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible. Maximum allowed lead length is 3 feet avoiding 90 degree bends. Do not locate surge protective devices inside a panelboard or switchboard enclosure.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.3.1 Remote Disconnecting Means Placards

For equipment with remote and/or lockable disconnecting means, provide a placard indicating the location of the disconnecting means.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting: as specified in Section 09 90 00 PAINTS AND COATINGS.Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 5 working days notice prior to each test. Where applicable, test electrical equipment in accordance with NETA ATS.

3.5.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of 1,000 volts DC for 600 volt rated wiring and 500 volts DC for 300 volt rated wiring per NETA ATS to provide direct reading of resistance. All existing wiring to be reused must also be tested.

3.5.3 Transformer Tests

3.5.3.1 Low- to Low-Voltage Transformer Tests

Perform the standard, not optional, tests in accordance with the Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in NETA ATS. Measure primary and secondary voltages for proper tap settings. Tests need not be performed by a recognized independent testing firm or independent electrical consulting firm.

3.5.3.2 Medium- to Low-Voltage Transformer Tests

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(4) Perform specific inspections and mechanical tests as recommended by manufacturer.

(5) Verify that resilient mounts are free and shipping brackets have been removed.

(6) Verify that winding core, frame, and enclosure groundings are correct.

(7) Verify that as-left tap connections are as specified.

b. Electrical Tests

(1) Perform insulation-resistance tests.

(2) Perform power-factor tests or dissipation-factor tests in accordance with the test equipment manufacturer's instructions.

(3) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(4) Perform turns-ratio tests.

(5) Perform an applied-voltage test on high and low voltage windings-to-ground. See IEEE C57.12.91. The ac dielectric-withstand-voltage test result must not exceed 75 percent of factory test voltage for one-minute duration. The dc dielectric-withstand-voltage test result must not exceed 100 percent of the ac rms test voltage specified in IEEE C57.12.91 for a one-minute duration. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.

(6) Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3.5.4 Ground-Fault Receptacle Test

Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed. Press the TEST button and then the RESET button to verify by LED status that the device is a self-test model as specified in UL 943.

3.5.5 Arc-Fault Receptacle Test

Test arc-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed. Press the TEST button and then the RESET button to verify by LED status that the device is a self-test model as specified in UL 1699.

3.5.6 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

3.5.7 Phase Rotation Test

Perform phase rotation test to ensure proper rotation of service power prior to operation of new or reinstalled equipment using a phase rotation meter. Follow the meter manual directions performing the test.

-- End of Section --

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SWITCHBOARDS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2014; Errata 2016) Electric Meters - Code for Electricity Metering

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2023) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D149	(2020) Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1535	(2014; R 2018) Standard Practice for Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth

	Surface Potentials of a Ground System
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C57.12.28	(2014) Standard for Pad-Mounted Equipment - Enclosure Integrity

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA PB 2.1	(2013) General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 V or Less
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA PB 2	(2011) Deadfront Distribution Switchboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 891	(2019) UL Standard for Safety Switchboards

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING and 25 05 11.05 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS- GENERATOR/SWITCHGEAR SCADA applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.4 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface". For this Section, any accessories requiring 600V or less station service electrical supply for function of the equipment (controls, actuators, battery chargers, heaters, etc.) shall be included in the CFCI Equipment Electrical Data submittal.

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchboard Drawings; G, DO

Switchboard drawings shall include detailed connection wiring diagrams and indicate all processors/platforms and connections to other systems such as SCADA, or other. Provide all documentation necessary for Risk Management Framework. Refer to Section 25 05 11.05 Cybersecurity of Facility-Related Control Systems - Genertaor Switchgear SCADA."

This item may (and is encouraged to) be submitted for preliminary review only prior or concurrent to the submittal and approval of the Section 26 05 73 analyses.

Submit this item after or concurrent to Section 26 20 00 Item: CFCI Equipment Electrical Data.

SD-03 Product Data

Switchboard; G, DO

This item may (and are encouraged to) be submitted for preliminary review only prior or concurrent to the submittal and approval of the Section 26 05 73 POWER SYSTEMS STUDIES.

Submit this item after or concurrent with Section 26 20 00 Item: CFCI Equipment Electrical Data.

SD-06 Test Reports

Switchboard Design Tests; G, DO

Switchboard Production Tests; G, DO

Acceptance Checks and Tests; G, DO

SD-07 Certificates

Cybersecurity Installation Certification; G, HNC

Submit certification indicating conformance with the paragraph

CYBERSECURITY INSTALLATION CERTIFICATION.

SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5; G, RO

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G, RO

Equipment Test Schedule; G, RO

Request for Settings; G, RO

Required Settings; G, RO

1.4.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.5 QUALITY ASSURANCE

1.5.1 Product Data

Include manufacturer's information on each submittal for each component, device and accessory provided with the switchboard including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings.

b. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device.

1.5.2 Switchboard Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices. Include the nameplate data, size, and capacity on submittal. Also include applicable federal, military, industry, and technical society publication references on submittals. Include the following:

a. One-line diagram including breakers, fuses, current transformers, and meters.

b. Outline drawings including front elevation, section views, footprint, and overall dimensions.

c. Bus configuration including dimensions and ampere ratings of bus bars.

d. Markings and NEMA nameplate data.

e. Circuit breaker type, interrupting rating, and trip devices, including available settings.

f. Wiring diagrams and elementary diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.

g. Manufacturer's instruction manuals and published time-current curves (in electronic format) of the main secondary breaker and largest secondary feeder device. Use this information (designer of record) to provide breaker settings that ensures protection and coordination are achieved.

Switchboard drawings shall indicate the load intended for each circuit breaker. A coordinating legend/schedule is acceptable.

1.5.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.4.2 Material and Equipment Manufacturing Date

Products manufactured more than one year prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

1.6.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.2 Assembled Operation and Maintenance Manuals

Assemble and securely bind manuals in durable, hard covered, water resistant binders. Assemble and index the manuals in the following order with a table of contents:

a. Manufacturer's O&M information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA.

b. Catalog data required by the paragraph SD-03, PRODUCT DATA.

c. Drawings required by the paragraph SD-02, SHOP DRAWINGS.

d. Prices for spare parts and supply list.

e. Information on metering.

f. Design test reports.

g. Production test reports.

1.7 WARRANTY

Provide equipment items that are supported by service organizations reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be switchboards and related accessories are specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SWITCHBOARD

NEMA PB 2 and UL 891.

2.2.1 Ratings

Provide equipment with the following ratings:

a. Voltage rating: 480Y/277 volts AC, three-phase, 4-wire.

b. Continuous current rating of the main bus: as indicated.

c. Short-circuit current rating: The greater of the value indicated on the plans and the value calculated in Section 26 05 73 POWER SYSTEMS STUDIES.

d. UL listed and labeled.

2.2.2 Construction

Provide the following for all switchboards:

a. Switchboard: consisting of one or more vertical sections bolted together to form a rigid assembly and aligned.

b. All circuit breakers: front accessible.

c. Rear aligned switchboards: front accessible load connections.

e. Where indicated, "space for future" or "space" means to include a vertical bus provided behind a blank front cover. Where indicated, "provision for future" means full hardware provided to mount a breaker suitable for the location.

f. Completely factory engineered and assembled, including equipment indicated with necessary interconnections, instrumentation, and control wiring.

2.2.2.1 Enclosure

Provide the following:

a. Enclosure: NEMA ICS 6 Type 1 fabricated entirely of minimum 12 gauge ASTM A240/A240M type 304 or 304L stainless steel.

b. Enclosure: bolted together with removable bolt-on side and rear covers, and sloping roof downward toward rear.

c. Front doors: provided with padlockable vault handles with a three point catch.

d. Bases, frames and channels of enclosure: corrosion resistant and fabricated of ASTM A240/A240M type 304 or 304L stainless steel or galvanized steel. Separate sections using vertical steel barriers.

e. Base: includes any part of enclosure that is within 3 inches of concrete pad.

f. Galvanized steel: ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

g. Paint color: ASTM D1535 light gray No. 61 or No. 49 over rust inhibitor.

h. Paint coating system: comply with IEEE C57.12.28 for galvanized steel.

2.2.2.2 Bus Bars

Provide the following:

a. Bus bars: copper with silver-plated contact surfaces.

(1) Phase bus bars: insulated with a tape wrap or insulating sleeve providing a minimum breakdown voltage of 16,000 volts per ASTM D149.

(2) Neutral bus: rated 100 percent of the main bus continuous current rating.

b. Make bus connections and joints with hardened steel bolts.

c. Main-bus (through bus): rated at the full ampacity of the main throughout the switchboard.

d. Minimum one-quarter by 2 inch copper ground bus secured to each vertical section along the entire length of the switchboard.

2.2.2.3 Main Section

Provide the main section consisting of an individually mounted circuit breaker.

2.2.2.4 Distribution Sections

Provide the distribution sections consisting of individually mounted, circuit breakers as indicated.

2.2.2.5 Auxiliary Sections

Provide auxiliary sections consisting of indicated instruments, metering equipment, control equipment, as indicated. Auxiliary components may be located in distribution sections, space and manufacturer permitting.

2.2.2.6 Handles

Provide handles for individually mounted devices of the same design and method of external operation. Label handles prominently to indicate device ampere rating, color coded for device type. Identify ON-OFF indication by handle position and by prominent marking.

2.2.3 Protective Device

Provide main, tie, and branch protective devices as indicated.

The circuit breaker ratings indicated on the one-line diagram and panel schedules are estimates based on basis of design equipment or standard ratings. Both solid-state and thermal magnetic-type circuit breaker ratings and/or settings are subject to change based on the manufacturer recommendations for equipment to be provided in this contract, including transformer inrush values and values for equipment not listed on the "Equipment Electrical Connection Schedule" but is provided as equipment installed under the contract. Contractor shall coordinate the protection device ratings with the equipment approved to be installed, is responsible for providing the appropriate ratings/settings, and shall indicate deviations from the design ratings in the submittal process, particularly when conductor protection is impacted by changes in protection rating.

Circuit breaker types must be based on the protective coordination study to selectively coordinate to the degree indicated in Section 26 05 73 POWER SYSTEM STUDIES, such as changing from one type of thermal magnetic circuit breaker to another within the same manufacturer (ie, from Siemens BQD to Siemens NGB, etc.). Circuit breakers shall not be considered accepted until power system study is accepted with "A" or "B" action.

2.2.3.1 Insulated-Case Breaker

Provide the following:

a. Main and Tie Breakers must be UL 489 UL listed and labeled, 100 percent rated breaker, true two step stored energy devices, electrically operated unless otherwise indicated on the contract douments. Circuit breakers are to be low voltage, insulated-case circuit breaker, with a short-circuit current rating as indicated at 480 volts and have 3 cycle short-time circuit withstand ratings.

b. Breaker frame size: as indicated.

c. Series rated circuit breakers are unacceptable.

d. All insulated case circuit breakers must have a nameplate clearly marking any electrical accessories that are mounted in the breaker at the installation. The accessory shall have a label that will indicate its function and voltage. All accessories shall be modular, plug and lock type, and UL listed for easy field installation.

e. The breaker control interface must have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a "Positive On" feature. The breaker flag will read "Closed" if the contacts are welded and the breaker is attempted to be tripped or opened.

2.2.3.2 Molded-Case Circuit Breaker

Provide the following:

a. UL 489. UL listed and labeled, 100 percent rated main breaker standard rated branch breakers, electrically operated, low voltage molded-case circuit breaker, with a short-circuit current rating of as indicated at 480Y/277volts. UL 489 solid-state circuit breakers shall be used where indicated in 26 05 73 POWER SYSTEM STUDIES.

b. Breaker frame size: as indicated.

c. Series rated circuit breakers are unacceptable.

2.2.4 Drawout Breakers

Provide drawout breakers as indicated. Equip drawout breakers with disconnecting contacts, wheels, and interlocks for drawout application. Provide main, auxiliary, and control disconnecting contacts with silver-plated, multifinger, positive pressure, self-aligning type. Provide each drawout breaker with four-position operation with each position clearly identified by an indicator on the circuit breaker front panel as follows.

a. Connected Position: Primary and secondary contacts are fully engaged. Breaker must be tripped before racking into or out of position.

b. Test Position: Primary contacts are disconnected but secondary contacts remain fully engaged. This position allows complete test and

operation of the breaker without energizing the primary circuit.

c. Disconnected Position: Primary and secondary contacts are disconnected.

d. Withdrawn (Removed) Position: Places breaker completely out of compartment, ready for removal. Removal of the breaker actuates assembly that isolates the primary stabs.

2.2.5 Electronic Trip Units

Equip main and distribution breakers as indicated with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that provides true rms sensing adjustable time-current circuit protection. Include the following:

a. Current sensors ampere rating: the same as the breaker frame rating.

b. Trip unit ampere rating: as indicated.

c. Ground fault protection: zero sequence sensing.

d. Electronic trip units: provide additional features as indicated:

(1) Indicated Breakers: include long delay pick-up and time settings, and LED indication of cause of circuit breaker trip.

(2) Main breakers: include short delay pick-up and time settings, instantaneous settings, and ground fault settings.

(3) Distribution breakers: include short delay pick-up and time settings and instantaneous settings.

(8) For electronic trip units that are rated for or can be adjusted to 1,200 amperes or higher, provide arc energy reduction capability with an energy-reducing maintenance switch with local status indicator.

2.2.6 Microprocessor Control Logic

a. Mechanical Switchboard A is to be provided with an microprocessor controller automatic logic controller. Operation of Mechanical Switchboard A and B main breakers("M1" and "M2") and monitoring of both sources shall be managed by the controller along with Tie Breaker "T2" located within Mechanical Switcboard A. The controller shall be hardened against transient voltages.

b. The controller shall have an operating temperature range from -20 to +70 degrees C (-4 to +158 degrees F) and a storage temperature range from -30 to +85 degrees C (-22 to +185 degrees F.

c. The controller shall be capable of accepting 120Vac derived from source 1 and source 2. An external 125 Vdc supply shall be accepted for continued controller operation if both sources have failed.

2.2.7 Adjustable Circuit Breaker Settings Cover

All adjustable circuit breakers shall be provided with a removable sealable cover over the adjusting means in accordance with 26 20 00

INTERIOR DISTRIBUTION SYSTEM.

2.2.8 Circuit Breaker Handle Locks and Lock-out Device

All circuit breakers supplying fire alarm circuits, or as otherwise indicated in the drawings, shall be provided with handle locks in accordance with 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2.9 Controller and Keypad

a. The microprocessor-based controller faceplate shall be UV resistant and include a 4.3-inch, color TFT (480x272) backlit display. The controller shall be capable of displaying source 1, 2, and tie breaker status, parameters, setpoints, and diagnostic data. Abbreviations or codes shall be limited for intuitive operation. All setpoint parameters shall be password protected

b. The microprocessor-based controller shall include one (1) unit status LED (3mm) and a mimic power bus consisting of six (6) LED's (3mm) for indicating the following:

c. The controller keypad shall include the following pushbutton controls:

d. The controller shall display on the main overview screen:

e. The controller shall display the voltage dropout and pickup setpoints, for source 1 and source 2, in volts and as a percentage of nominal voltage

f. The controller shall display the frequency dropout and pickup setpoints, for source 1 and source 2, in hertz and as a percentage of nominal frequency.

g. The controller shall monitor voltage (Vab, Vbc, Vca) and frequency (Hz) for source 1, source 2, and load.

h. The controller shall have a voltage range of 0-720 Vrms with an accuracy of +/- 1%. Nominal voltage shall be adjustable in 1 volt increments from 120 to 600Vac. The number of voltage phases shall be adjustable as 1 or 3.

i. The controller shall have a frequency range of 40-80 Hz with an accuracy of +/- 0.2 Hz. Nominal frequency shall be adjustable as 50 or 60Hz.

j. The controller shall include a phase sequence check for source 1 and source 2, adjustable to OFF, ABC, or CBA.

k. Voltage and frequency dropout and pickup setpoints, for source 1 and source 2, shall be adjustable as a percentage of nominal per the table below. Pickup and dropout setpoints for overvoltage, underfrequency, overfrequency, and voltage unbalance / phase loss shall be capable of being disabled.

Setpoint	Sources	Dropout	Pickup
Undervoltage	Source 1 and 2	70 - 97%	(Do +2%) to 99$
Overvoltage	Source 1 and 2	105 - 120%	103% to (DO -2%)
Underfrequency	Source 1 and 2	90 - 97%	(DO + 1HZ) to 99%
Overfrequency	Source 1 and 2	103 - 110%	101% to (DO - 1Hz)
Voltage Unbalance	Source 1 and 2	5 - 20%	3% to (DO - 2%)
Voltage Unbalance Phase Loss (with negative sequence detection)	Source 1 and 2	20 - 60%	18% to (DO - 2%)

l. The controller shall include an algorithm that is capable of detecting a voltage unbalance / phase loss condition at either power source when the power source is unloaded and regenerated, or phantom voltage is present. Once detected, the algorithm shall be capable of preventing a load transfer into a regenerated voltage condition.

m. A setpoint shall be provided for configuring a "preferred source", adjustable to none, source 1, or source 2. The controller shall seek connection of the load to the preferred source (when it is available). The controller shall also be capable of accepting an external dry contact for remotely configuring source 1 or source 2 as the preferred source.

2.2.10 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Provide short-circuiting type terminal boards associated with current transformer. Terminate conductors for current transformers with ring-tongue lugs. Provide terminal board identification that is identical in similar units. Provide color coded external wiring that is color coded consistently for similar terminal boards.

2.2.11 Wire Marking

Mark control and metering conductors at each end. Provide factory installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Provide a single letter or number on each sleeve, elliptically shaped to securely grip the wire, and keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Indicate on each wire marker the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.3 MANUFACTURER'S NAMEPLATE

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a

conspicuous place; the nameplate of the distributing agent is not acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.4 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each switchboard, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Identify on each nameplate inscription the function and, when applicable, the position. Provide nameplates of melamine plastic, 0.125 inch thick, white with black center core. Provide red laminated plastic label with white center core where indicated. Provide matte finish surface. Provide square corners. Accurately align lettering and engrave into the core. Provide nameplates with minimum size of one by 2.5 inches. Provide lettering that is a minimum of 0.25 inch high normal block style.

2.5 SOURCE QUALITY CONTROL

2.5.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

Provide the following as part of test equipment calibration:

a. Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

b. Accuracy: Traceable to the National Institute of Standards and Technology.

c. Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.

d. Dated calibration labels: visible on all test equipment.

e. Calibrating standard: higher accuracy than that of the instrument tested.

f. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

    (1) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

    (2) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.5.2 Switchboard Design Tests

NEMA PB 2 and UL 891.

2.5.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

a. Short-circuit current test.

b. Enclosure tests.

c. Dielectric test.

2.5.2.2 Additional Design Tests

In addition to normal design tests, perform the following tests on the actual equipment. Furnish reports which include results of design tests performed on the actual equipment.

a. Temperature rise tests.

b. Continuous current.

2.5.3 Switchboard Production Tests

NEMA PB 2 and UL 891. Furnish reports which include results of production tests performed on the actual equipment for this project. These tests include:

a. 60-hertz dielectric tests.

b. Mechanical operation tests.

c. Electrical operation and control wiring tests.

d. Ground fault sensing equipment test.

2.6 COORDINATED POWER SYSTEM PROTECTION

Provide a power system study as specified in Section 26 05 73 POWER SYSTEM STUDIES.

2.7 ARC FLASH WARNING LABEL

Provide warning label for switchboards. Locate this self-adhesive warning label on the outside of the enclosure warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

2.8 SURGE PROTECTIVE DEVICE(S)

Provide surge protective devices (SPDs) as indicated on the plans. Reference Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM for surge protective device requirements. SPDs shall not be located inside the switchboard unless a separate compartment is provided. Provide Form C dry contacts for remote monitoring, and indicate to the reporting system when the unit has malfunctioned and/or requires replacement (SPDs shall be provided with local visual indicators for the same diagnostics; UFC 3-520-01 Sections 3-4.1.1 and 3-4.1.2). SPD submittals shall include the manufacturer's recommended onvercurrent protective device rating for the device(s) to be installed, and the circuit breaker ratings and conductor

sizes shall be adjusted accordingly at no additional cost to the government.

PART 3 EXECUTION

3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 SEQUENCE OF OPERATIONS (Reference Sheet EP602, MECHANICAL SWITCHBOARD A & MECHANICAL SWITCHBOARD B)

3.2.1 Normal Conditions (Power at Breaker "M1" and at Breaker "M2")

a. Breakers "M1", "M2" and "T1" are Normally Closed.

b. Breaker "T2" is Normally Open.

3.2.2 Emergency Condition 1 (Loss of Power at Breaker "M1" and Power Present at Breaker "M2"), system is break before make.

a. Breaker "M1" Opens.

b. Breaker "T2" Closes.

c. When Power is restored at Breaker "M1": Breaker "T2" Opens then Breaker "M1" Closes.

3.2.3 Emergency Condition 2 (Power Present at Breaker "M1" and Loss of Power at Breaker "M2"), system is break before make.

a. Breaker "M2" Opens.

b. Breaker "T2" Closes.

c. When Power is restored at Breaker "M2": Breaker "T2" Opens then Breaker "M2" Closes.

3.3 GROUNDING

NFPA 70 and IEEE C2, except that grounds and grounding systems with a resistance to solid earth ground not exceeding 5 ohms. Ground switchboards as indicated on Sheet EG600.

3.3.1 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 24 inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" applies.

3.3.2 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL

DISTRIBUTION.

3.3.3 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.4 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.4.1 Switchboard

ANSI/NEMA PB 2.1.

3.4.2 Meters and Instrument Transformers

ANSI C12.1.

3.4.3 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.4.4 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.4.5 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.5.1 Interior Location

Mount switchboard on concrete slab as follows:

a. Unless otherwise indicated, provide the slab with dimensions at least 4 inches thick. Account for concrete pad in switchboard assembly such that height of circuit breakers satisfies the NFPA 70 maximum operable height.

b. Install slab such that the top of the concrete slab is approximately 4 inches above the finished grade.

c. Provide edges above grade 1/2 inch chamfer.

d. Provide slab of adequate size to project at least 8 inches beyond the equipment.

e. Provide conduit turnups and cable entrance space required by the

equipment to be mounted.

f. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant.

g. Cut off and bush conduits 3 inches above slab surface.

h. Provide concrete work as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.6 FIELD QUALITY CONTROL

Submit request for settings of breakers to the Contracting Officer after approval of switchboard and at least 30 days in advance of their requirement.

Submit Required Settings of breakers to the Contracting Officer after approval of switchboard and at least 30 days in advance of their requirement.

3.6.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.6.1.1 Switchboard Assemblies

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical, electrical, and mechanical condition.

(3) Verify appropriate anchorage, required area clearances, and correct alignment.

(4) Clean switchboard and verify shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.

(5) Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

(6) Verify that circuit breaker sizes and types correspond to approved shop drawings as well as to the circuit breaker’s address for microprocessor-communication packages.

(8) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(9) Confirm correct operation and sequencing of electrical and mechanical interlock systems.

(10) Confirm correct application of manufacturer's recommended lubricants.

(11) Inspect insulators for evidence of physical damage or contaminated surfaces.

(12) Verify correct barrier installation.

(13) Exercise all active components.

(14) Inspect all mechanical indicating devices for correct operation.

(15) Verify that filters are in place and vents are clear.

(16) Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

(17) Inspect control power transformers.

b. Electrical Tests

(1) Perform insulation-resistance tests on each bus section.

(2) Perform dielectric withstand voltage tests.

(3) Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

(4) Perform control wiring performance test.

(5) Perform primary current injection tests on the entire current circuit in each section of assembly.

(6) Perform phasing check on double-ended switchboard to ensure correct bus phasing from each source.

3.6.1.2 Circuit Breakers - Low Voltage - Power

a. Visual and Mechanical Inspection

(1) Compare nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect anchorage, alignment, and grounding.

(4) Verify that all maintenance devices are available for servicing and operating the breaker.

(5) Inspect arc chutes.

(6) Inspect moving and stationary contacts for condition, wear, and alignment.

(7) Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.

(8) Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.

(9) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(10) Verify cell fit and element alignment.

(11) Verify racking mechanism.

(12) Confirm correct application of manufacturer's recommended lubricants.

b. Electrical Tests

(1) Perform contact-resistance tests on each breaker.

(2) Perform insulation-resistance tests.

(3) Adjust Breaker(s) for final settings in accordance with Government provided settings.

(4) Determine long-time minimum pickup current by primary current injection.

(5) Determine long-time delay by primary current injection.

(6) Determine short-time pickup and delay by primary current injection.

(7) Determine ground-fault pickup and delay by primary current injection.

(8) Determine instantaneous pickup value by primary current injection.

(10) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.

(11) Verify operation of charging mechanism.

3.6.1.3 Circuit Breakers

Low Voltage Molded Case with Solid State Trips

a. Visual and Mechanical Inspection

(1) Compare nameplate data with specifications and approved shop drawings.

(2) Inspect circuit breaker for correct mounting.

(3) Operate circuit breaker to ensure smooth operation.

(4) Inspect case for cracks or other defects.

(5) Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

(1) Perform contact-resistance tests.

(2) Perform insulation-resistance tests.

(3) Perform Breaker adjustments for final settings in accordance with Government provided settings.

(4) Perform long-time delay time-current characteristic tests

(5) Determine short-time pickup and delay by primary current injection.

(6) Determine ground-fault pickup and time delay by primary current injection.

(7) Determine instantaneous pickup current by primary injection.

3.6.1.4 Current Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

(6) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

(1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

(2) Perform insulation-resistance tests.

(3) Perform polarity tests.

(4) Perform ratio-verification tests.

3.6.1.5 Metering and Instrumentation

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests

(1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

(2) Calibrate watthour meters according to manufacturer's published data.

(3) Verify all instrument multipliers.

(4) Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.6.1.6 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) IEEE 81. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

(2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.6.1.7 Cybersecurity Installation Certification

Furnish a certification that control systems are installed in accordance with DoD Instruction 8500.01, DoD Instruction 8510.01, and as required by the related Section 25 05 11 variant.

3.6.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Trip circuit

breakers by operation of each protective device. Test each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, provide the Contracting Officer five working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

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SECTION 26 29 23

ADJUSTABLE SPEED DRIVE (ASD) SYSTEMS UNDER 600 VOLTS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

EUROPEAN COMMITTEE FOR STANDARDIZATION (CEN/CENELEC)

EN 61800-3	(2017) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 519	(2022) Standard for Harmonic Control in Electrical Power Systems
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61000-3-12	(2012) Electromagnetic Compatibility (EMC) - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and </=75 A per phase

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 3.1	(2019) Guide for the Application, Handling, Storage, Installation and Maintenance of Medium-Voltage AC Contactors, Controllers and Control Centers
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA ICS 7	(2020) Adjustable-Speed Drives

NEMA ICS 7.2	(2015) Application Guide for AC Adjustable Speed Drive Systems
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UL SOLUTIONS (UL)

UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 61800-5-1	(2016) Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

1.3.1 Performance Requirements

1.3.1.1 Electromagnetic Interference Suppression

Computing devices, as defined by 47 CFR 15 and EN 61800-3 rules and regulations, must be certified to comply with the requirements for class A computing devices and labeled.

1.3.1.2 Electromechanical and Electrical Components

Ensure electrical and electromechanical components of the Adjustable Speed Drive (ASD) do not cause electromagnetic interference to adjacent electrical or electromechanical equipment while in operation.

1.3.2 Electrical Requirements

1.3.2.1 Power Line Surge Protection

IEEE C62.41.1 and IEEE C62.41.2, IEEE 519, IEC 61000-3-12 Control panels must have surge protection, included within the panel to protect the unit from damaging transient voltage surges. Surge protective device must be mounted near the incoming power source and properly wired to all three phases and ground. Fuses must not be used for surge protection.

1.3.2.2 Sensor and Control Wiring Surge Protection

I/O functions as specified must be protected against surges induced on control and sensor wiring installed outdoors and as shown. Test the inputs and outputs in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.4 SUBMITTALS

The Contractor shall not submit nor shall submittals be considered approved for installation on any electrical equipment containing overcurrent protective devices or requiring a short circuit rating or an arc flash rating until the Protective Coordination with Arc Flash Hazard Study (Section 26 28 01.00 10) has been submitted for review by the Contractor and until it has been approved (transmittal "A" or "B" Action) by the reviewing agent. Government approval is required for submittals with a "G" designation. Submittals not having a "G" designation are for information only. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Schematic Diagrams; G, DO

Schematic Diagrams (Generator Supply Fans); G, DO

The ASDs associated with the Generator Supply Fans shall be submitted concurrent to the Generator Supply Fans (see Section 23 30 00 references to "Axial Flow Fans"). All other ASDs may be submitted under a separate cover. The review period for the items requiring concurrent submission shall not commence until the last of the required concurrent submittal items is received by the government.

Interconnecting Diagrams; G, DO

Installation Drawings; G, DO

As-Built Drawings; G, RO

SD-03 Product Data

Contractor shall include in submittals manufacturer data for voltage, phase, rated full load ampacity (FLA), minimum circuit ampacity (MCA), and maximum overcurrent protection (MOCP) device rating requirements for sizing in accordance with NFPA 70 Article 430 Part X provisions. Coordinate with the "Mechanical Equipment

Electrical Coordination Schedule" sheet for additional requirements. Voltage and phase requirements shall not deviate from those listed on the "Equipment Electrical Coordination Schedule" without government approval for a variance. See paragraph "Variable frequency drives" in Part 2 "Products" for additional requirements. Include in submittal the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

Adjustable Speed Drives; G, DO

Adjustable Speed Drives (Generator Supply Fans); G, DO

The ASDs associated with the Generator Supply Fans shall be submitted concurrent to the Generator Supply Fans (see Section 23 30 00 references to "Axial Flow Fans"). All other ASDs may be submitted under a separate cover. The ASDs associated with the Generator Supply Fans shall be submitted concurrent to the Generator Supply Fans. All other ASDs may be submitted under a separate cover. The review period for the items requiring concurrent submission shall not commence until the last of the required concurrent submittal items is received by the government.

Wires and Cables

Equipment Schedule

SD-06 Test Reports

ASD Test

Performance Verification Tests

Endurance Test

SD-08 Manufacturer's Instructions

Installation instructions

SD-09 Manufacturer's Field Reports

ASD Test Plan; G, RO

Standard Products

Testing Agency's Field Supervisor

SD-10 Operation and Maintenance Data

Adjustable Speed Drives, Data Package 4

1.4.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.5 QUALITY ASSURANCE

1.5.1 Schematic Diagrams

Submit diagrams showing circuits and device elements for each replaceable module. Schematic diagrams of printed circuit boards are permitted to group functional assemblies as devices, provided that sufficient information is provided for government maintenance personnel to verify proper operation of the functional assemblies.

Furnish Schematic Diagrams (Generator Supply Fans) shop drawings concurrent to the Generator Supply Fan product submittals.

1.5.2 Interconnecting Diagrams

Show interconnections between equipment assemblies, and external interfaces, including power and signal conductors. Include for enclosures and external devices.

1.5.3 Installation Drawings

Show floor plan of each site, with ASD's and motors indicated. Indicate ventilation requirements, adequate clearances, and cable routes. Submit drawings for government approval prior to equipment construction or integration. Immediately record modifications to original drawings made during installation for inclusion into the as-built drawings.

1.5.4 Equipment Schedule

Provide schedule of equipment supplied. Schedule must provide a cross reference between manufacturer data and identifiers indicated in shop drawings. Schedule must include the total quantity of each item of equipment supplied and data indicating compatibility with motors being driven. For complete assemblies, such as ASD's, provide the serial numbers of each assembly, and a sub-schedule of components within the assembly. Provide recommended spare parts listing for each assembly or component.

1.5.5 Installation Instructions

Provide installation instructions issued by the manufacturer of the equipment, including notes and recommendations, prior to shipment to the site. Provide operation instructions prior to acceptance testing.

1.5.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component

parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6 DELIVERY AND STORAGE

Store delivered equipment to protect from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.7 WARRANTY

The complete system must be warranted by the manufacturer for a period of one year. Repair or replace any component failing to perform its function as specified and documented at no additional cost to the Government. Items repaired or replaced must be warranted for an additional period of at least one year from the date that it becomes functional again, as specified in FAR 52.246-21 Warranty of Construction.

1.8 MAINTENANCE

1.8.1 Spare Parts

Manufacturers provide spare parts in accordance with recommended spare parts list.

Provide one spare ASD of each model provided for HVAC equipment, fully programmed and ready for back-up operation when connected.

1.8.2 Operation and Maintenance Data

Provide in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Provide service and maintenance information including preventive maintenance, assembly, and disassembly procedures. Include electrical drawings from electrical general sections. Provide additional information necessary to provide complete operation, repair, and maintenance information, detailed to the smallest replaceable unit. Include copies of as-built submittals. Provide routine preventative maintenance instructions, and equipment required. Provide instructions on how to modify program settings, and modify the control program. Provide instructions on drive adjustment, trouble-shooting, and configuration. Provide instructions on process tuning and system calibration.

1.8.3 Maintenance Support

During the warranty period, provide on-site, on-call maintenance services by drive manufacturer's personnel on the following basis: The service must be on a per-call basis with 36 hour response. Contractor is responsible for the maintenance of all hardware and software of the system during the warranty period. Various personnel of different expertise must be sent on-site depending on the nature of the maintenance service required. Costs must include travel, local transportation, living expenses, and labor rates of the service personnel while responding to the service request. The provisions of this Section are not in lieu of, nor relieve the Contractor of, warranty responsibilities covered in this specification. Should the result of the service request be the uncovering of a system defect covered under the warranty provisions, all costs for the call, including the labor necessary to identify the defect, must be borne by the Contractor.

1.8.4 Technical Support

Provide the ASDs with manufacturer's technical telephone support in English, readily available during normal working hours.

PART 2 PRODUCTS

2.1 ADJUSTABLE SPEED DRIVES (ASD)

Furnish Adjustable Speed Drives (Generator Supply Fans) product data concurrent to the Generator Supply Fan product submittals.

Provide adjustable speed drive to control the speed of induction motor(s). The ASD must include the following minimum functions, features and ratings.

a. Input circuit breaker per UL 489 with a minimum interrupting capacity to interrupt the fault calculated at the position in the electrical distribution system in which the ASD is installed (but not less than 10,000 amps) and door interlocked external operator.

b. A converter stage per UL 61800-5-1 must change fixed voltage, fixed frequency, ac line power to a fixed dc voltage. The converter must utilize a full wave bridge design incorporating diode rectifiers. Silicon Controlled Rectifiers (SCR) are not acceptable. The converter must be insensitive to three phase rotation of the ac line and must not cause displacement power factor of less than .95 lagging under any speed and load condition.

c. An inverter stage must change fixed dc voltage to variable frequency, variable ac voltage for application to a standard NEMA MG 1 Part 30 motor designed for use with adjustable frequency power supplies. Switch the inverter to produce a sine coded pulse width modulated (PWM) output waveform.

d. The ASD shall be capable of supplying 110 percent of rated full load current for one minute at maximum ambient temperature.

e. The ASD must be designed to operate from the voltage source identified on the plans, plus or minus 10 percent, three phase, 60 Hz supply, and control motors with a corresponding voltage rating.

f. Acceleration and deceleration time must be independently adjustable from one second to 60 seconds.

Required deceleration time may be achieved using not only dynamic braking resistor but with other methods described in NEMA ICS 7.2-2015 paragraph 5.2.5.

g. Adjustable full-time current limiting must limit the current to a preset value which must not exceed 110 percent of the controller rated current. The current limiting action must maintain the V/Hz ratio constant so that variable torque can be maintained. Short time starting override must allow starting current to reach 175 percent of controller rated current to maximum starting torque.

h. The controllers must be capable of producing an output frequency over the range of 3 Hz to 60 Hz (20 to one speed range), without low speed cogging. Over frequency protection must be included such that a

failure in the controller electronic circuitry must not cause frequency to exceed 110 percent of the maximum controller output frequency selected.

i. Minimum and maximum output frequency must be adjustable over the following ranges: 1) Minimum frequency 3 Hz to 50 percent of maximum selected frequency; 2) Maximum frequency 40 Hz to 60 Hz.

j. The controller efficiency at any speed must not be less than 96 percent.

k. The controllers must be capable of being restarted into a motor coasting in the forward direction without tripping.

l. Protection of power semiconductor components must be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controllers to any of the following conditions must not result in component failure or the need for fuse replacement:

(1) Short circuit at controller output

(2) Ground fault at controller output

(3) Open circuit at controller output

(4) Input undervoltage

(5) Input overvoltage

(6) Loss of input phase

(7) AC line switching transients

(8) Instantaneous overload

(9) Sustained overload exceeding 115 percent of controller rated current

(10) Over temperature

(11) Phase reversal

m. Solid state motor overload protection must be included such that current exceeding an adjustable threshold must activate a 60 second timing circuit. Should current remain above the threshold continuously for the timing period, the controller will automatically shut down.

n. Include slip compensation circuit that will sense changing motor load conditions and adjust output frequency to provide speed regulation of NEMA MG 1 Part 30 designed for use with adjustable frequency power supplies motors to within plus or minus 0.5 percent of maximum speed without the necessity of a tachometer generator.

o. The ASD must be factory set for manual restart after the first protective circuit trip for malfunction (overcurrent, undervoltage, overvoltage or overtemperature) or an interruption of power. The ASD must be capable of being set for automatic restart after a selected time delay. If the drive faults again within a specified time period

(adjustable 0-60 seconds), a manual restart will be required.

p. The ASD must include external fault reset capability. All the necessary logic to accept an external fault reset contact must be included.

q. Provide critical speed lockout circuitry to prevent operating at frequencies with critical harmonics that cause resonant vibrations. The ASD must have a minimum of three user selectable bandwidths.

r. Provide preperly sized NEMA rated by-pass and isolation contactors to enable operation of motor in the event of ASD failure and for safety transfers motor between power converter output and bypass circuit using a field-selectable automatic and manual bypass mode. Install mechanical and electrical interlocks between the by-pass and isolation contactors. Provide a selector switch and transfer delay timer. Motor overload and short circuit protective features must remain in use during the bypass mode.

s. Each individual ASD must meet the following Total Harmonic Distortion (THD) requirements at the input terminals to the factory assembly of the ASD or at the load disconnecting means serving the ASD and filter assembly. These measurements should be taken with the drive set at 90 percent frequency (rpms) and the motor under a minimum of 50 percent demand.

(1) The Voltage THD should not exceed 2.0 percent THD.

(2) The Current THD should not exceed 15.0 percent THD.

(3) If the standard factory ASD does not meet or exceed these requirements the factory must install appropriate equipment (Harmonic Traps, Filters, different Drive technology, etc.) to mitigate the distortion to assure performance of the VFD is within the limits.

(4) These tests should be performed at the Manufacturers Laboratory facilities and submitted as part of the Product Data Submittals, in order to prevent the necessity of adding mitigation equipment in the field. If the requirements listed above are met, IEEE 519 will also be met.

t. Minimum Operating Conditions. Designed and constructed ASD's to operate within the following service conditions:

(1) Ambient Temperature Rating: 0 to 120 degrees F.

(2) Non-condensing relative humidity rating: less than 95 percent.

(3) Ambient rating: Rated for (or derated for) an altitude of 5,600 feet.

ASD (VFD) shall be provided with by-pass as described above and shall have circuits sized as follows:

1. Conductors shall be the larger of the following:
a. Minimum circuit ampacity (MCA)_of the equipment on the load side of the VFD.
b. 125 percent of the VFD's maximum input current.

c. The conductor sizes shall be subject to ASHRAE 90.1-IP branch circuit voltage drop restrictions.

2. Panelboard circuit breaker overcurrent protection shall be no larger than the manufacturer's OCP of the equipment on the load side of the VFD.

3. Disconnecting means shall be rated for 115 percent of the rated input current of the VFD.

Should a VFD be sized for a capacity larger than the equipment on the load side of the VFD provided, the circuit breaker for the VFD supply circuit shall govern at the panelboard if it is larger than the end equipment MOCP, and the VFD bypass circuit shall be provided with a separate overcurrent protection device sized per the end equipment MOCP.

Reference NFPA 70 Article 430 Part X.

Circuiting to include circuit breaker, conductor, and disconnect sizes shown on the drawings is subject to change based on the equipment submitted to be installed. Changes for these reasons are expected to be minor and shall be at no additional cost to the government. Fusing required by equipment or by this Section but is not shown on the drawings shall be at no additional cost to the government.

2.1.1 ASD for Industrial Application

Provide the following operator control and monitoring devices mounted on the front panel of the ASD:

a. Manual speed potentiometer.

b. Hand-Off-Auto (HOA) switch.

c. Power on light.

d. Drive run power light.

e. Local display capable of including ASD status, frequency, motor RPM, phase current, fault diagnostic in descriptive text, and all programmed parameters.

2.1.2 ASD for HVAC Application

ASDs must have the following features:

a. A local operator control providing the following functions:

(1) Remote/Local operator selection with password access.

(2) Run/Stop and manual speed commands.

(3) All programming functions.

(4) Scrolling through all display functions.

b. A local operator control panel with the following data displayed:

(1) ASD status.

(2) Frequency.

(3) Motor RPM.

(4) Phase current.

(5) Scrolling through all display functions.

(6) Fault diagnostics in descriptive text.

(7) All programmed parameters.

c. Standard PI loop controller with input terminal for controlled variable and parameter settings.

d. User interface terminals for remote control of ASD speed, speed feedback, and an isolated form C SPDT relay, which energizes on a drive fault condition.

e. An isolated form C SPDT auxiliary relay which energizes on a run command.

f. An adjustable carrier frequency with 16 KHz minimum upper limit.

g. A built-in or external line reactor with 3 percent minimum impedance to protect the DC bus capacitors and rectifier section diodes, reduce power line transient voltage, line notching, DC bus over-voltage tripping and improve the inverter over-current and over-voltage conditions.

h. Historical logging information and displays:

(1) Running log of total power versus time.

(2) Total run time.

i. The ASD must be capable of automatic control by the building automation system (see Division 23 Control Specifications) or manually by the ASD control panel.

j. ASDs must include the following operator programmable parameters:

(1) Upper and lower limit frequency.

(2) Acceleration and deceleration rate.

(3) Variable torque volts per Hertz curve.

(4) Starting voltage level.

(5) Starting frequency level.

(6) Display speed scaling.

(7) Enable/disable soft stall feature.

(8) Motor overload level.

(9) Motor stall level.

(10) Jump frequency and hysteresis band.

(11) PWM carrier frequency.

k. ASD must have the following protective features:

(1) An electronic adjustable inverse time current limit with consideration for additional heating of the motor at frequencies below 45Hz, for the protection of the motor.

(2) An electronic adjustable soft stall feature, allowing the ASD to lower the frequency to a point where the motor will not exceed the full-load amperage when an overload ASD will automatically return to the requested frequency when load conditions permit.

(3) A separate electronic stall at 110 percent ASD rated current, and a separate hardware trip at 190 percent current.

(4) The ability to shut down if inadvertently started into a rotating load without damaging the ASD or the motor.

(5) The ability to keep a log of a minimum of four previous fault conditions, indicating the fault type and time of occurrence in descriptive text.

(6) The ability to sustain 110 percent rated current for 60 seconds.

(7) The ability to shutdown safely or protect against and record the following fault conditions:

(a) Over current (and an indication if the over current was during acceleration, deceleration, or running).

(b) Over current internal to the drive.

(c) Motor overload at start-up.

(d) Over voltage from utility power.

(e) Motor running overload.

(f) Over voltage during deceleration.

(g) ASD over heat.

(h) Load and ground fault.

(i) Abnormal parameters or data in ASD EEPROM.

2.2 ENCLOSURES

Provide equipment enclosures conforming to NEMA 250, NEMA ICS 7, and NEMA ICS 6, with a heater if located outdoors. An HMCP device shall provide the disconnecting means. The operating handle shall protrude through the door, but the disconnect shall not be mounted on the door. The handle shall indicate ON, OFF, and tripped conditions. The handle shall have provisions to accommodate a minimum of three padlocks in the

OFF position. Interlocks shall prevent unauthorized opening or closing of the ASD door with the disconnect handle in the ON position. The door handle interlock should have provisions to be defeated by qualified maintenance personnel.

2.3 WIRES AND CABLES

All wires and cables must conform to NEMA 250, NEMA ICS 7, NFPA 70.

2.4 NAMEPLATES

Nameplates external to NEMA enclosures must conform with the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide manufacturer's standard, permanent nameplates for internal areas of enclosures.

2.5 SOURCE QUALITY CONTROL

2.5.1 ASD Test Plan

To ensure quality, each ASD must be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities. Provide test plans.

2.5.2 ASD Test Report

To ensure quality, each ASD must be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities. Provide test reports.

PART 3 EXECUTION

3.1 INSTALLATION

Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings. A field representative of the drive manufacturer must supervise the installation of all equipment, and wiring.

3.2 GROUNDING

Per NEMA ICS 7.2, ASD must be solidly grounded to the main distribution.

3.3 FIELD QUALITY CONTROL

Specified products must be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. Conduct performance verification tests in the presence of Government representative, observing and documenting complete compliance of the system to the specifications. Submit a signed copy of the test results, certifying proper system operation before scheduling tests.

3.3.1 ASD Test

A proposed test plan must be submitted to the contracting officer at least 28 calendar days prior to proposed testing for approval. The tests must conform to NEMA ICS 1, NEMA ICS 7, and all manufacturer's safety regulations. The Government reserves the right to witness all tests and review any documentation. Inform the Government at least 14 working days

prior to the dates of testing. Perform the ASD test engaging a qualified testing agency's field supervisor currently certified by NETA to supervise on-site testing.

3.3.2 Performance Verification Tests

"Performance Verification Test" plan must provide the step by step procedure required to establish formal verification of the performance of the ASD. Compliance with the specification requirements must be verified by inspections, review of critical data, demonstrations, and tests. The Government reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements. Inform the Government 14 calendar days prior to the date the test is to be conducted.

3.3.3 Endurance Test

Immediately upon completion of the performance verification test, the endurance test must commence. The system must be operated at varying rates for not less than 192 consecutive hours, at an average effectiveness level of 0.9998, to demonstrate proper functioning of the complete PCS. Continue the test on a day-to-day basis until performance standard is met. The contractor is not allowed in the building during the endurance test. The system must respond as designed.

3.4 DEMONSTRATION

3.4.1 Training

Coordinate training requirements with the Contracting Officer. Provide video tapes, if available, of all training provided to the Government for subsequent use in training new personnel. Provide all training aids, texts, and expendable support material for a self-sufficient presentation shall be provided, the amount of which to be determined by the contracting officer.

3.4.1.1 Instructions to Government Personnel

Provide the services of competent instructors with minimum two-year field experience with the operation and maintenance of similar ASDs who will give full instruction to designated personnel in operation, maintenance, calibration, configuration, and programming of the complete control system. Orient the training specifically to the system installed. Instructors must be thoroughly familiar with the subject matter they are to teach. The number of training days of instruction furnished must be as specified. A training day is defined as eight hours of instruction, including two 15-minute breaks and excluding lunch time; Monday through Friday. Provide a training manual for each student at each training phase which describes in detail the material included in each training program. Provide one additional copy for archiving. Provide equipment and materials required for classroom training. Provide a list of additional related courses, and offers, noting any courses recommended. List each training course individually by name, including duration, approximate cost per person, and location of course. Unused copies of training manuals must be turned over to the Government at the end of last training session.

3.4.1.2 Operating Personnel Training Program

Provide one 2-hour training session at the site at a time and place mutually agreeable between the Contractor and the Government. Provide session to train 4 operation personnel in the functional operations of the system and the procedures that personnel will follow in system operation. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. Alarm formats

e. Failure recovery procedures

f. Troubleshooting

3.4.1.3 Engineering/Maintenance Personnel Training

Accomplish the training program as specified. Training must be conducted on site at a location designated by the Government. Provide a one-day training session to train four engineering personnel in the functional operations of the system. This training must include:

a. System overview

b. General theory of operation

c. System operation

d. System configuration

e. Alarm formats

f. Failure recovery procedures

g. Troubleshooting and repair

h. Maintenance and calibration

i. System programming and configuration

-- End of Section --

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SECTION 26 32 15

ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES

05/24

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SECTION 26 32 15

ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES
05/24

PART 1 GENERAL

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1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B31.1	(2022) Power Piping
ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2013) Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A106/A106M	(2019a) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A126	(2004; R 2023) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A181/A181M	(2014; R 2020) Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A234/A234M	(2023a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM B395/B395M	(2018) Standard Specification for U-Bend Seamless Copper and Copper Alloy Heat Exchanger and Condenser Tubes
ASTM D975	(2020) Standard Specification for Diesel Fuel Oils

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)

EGSA 101P	(1995) Performance Standard for Engine Driven Generator Sets

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1	(2000; R 2011) General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation
IEEE 43	(2013) Recommended Practice for Testing Insulation Resistance of Rotating Machinery
IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth

	Surface Potentials of a Ground System
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 115	(2019) Guide for Test Procedures for Synchronous Machines: Part I Acceptance and Performance Testing; Part II Test Procedures and Parameter Determination for Dynamic Analysis
IEEE 120	(1989; R 2007) Master Test Guide for Electrical Measurements in Power Circuits
IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE 519	(2022) Standard for Harmonic Control in Electrical Power Systems
IEEE C2	(2023) National Electrical Safety Code
IEEE C50.12	(2005; R 2010) Standard for Salient Pole 50 HZ and 60 Hz Synchronous Generators and Generation/Motors for Hydraulic Turbine Applications Rated 5 MVA and above
IEEE C57.13.1	(2006; R 2012) Guide for Field Testing of Relaying Current Transformers
IEEE C57.32	(2015) Requirements, Terminology, and Test Procedure for Neutral Grounding Devices

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2024) International Building Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60034-2A	(1974; ED 1.0) Rotating Electrical Machines Part 2: Methods for Determining Losses and Efficiency of Rotating Electrical Machinery from Tests (Excluding Machines for Traction Vehicles) Measurement of Losses by the Calorimetric Method

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 3046	(2002, 2006, 2009, 2001) Reciprocating Internal Combustion Engines - Performance--Part 1, 3, 4, 5, 6

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2018) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
NEMA/ANSI C12.11	(2006; R 2019) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024) Flammable and Combustible Liquids Code
NFPA 37	(2024) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 54	(2024) National Fuel Gas Code
NFPA 58	(2024; TIA 23-1) Liquefied Petroleum Gas Code
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National

	Electrical Code
NFPA 110	(2022) Standard for Emergency and Standby Power Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE ARP892	(1965; R 1994) DC Starter-Generator, Engine
SAE J537	(2016) Storage Batteries

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-461	(2015; Rev G) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
UFC 3-301-01	(2023; with Change 2, 2024) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 60	Standards of Performance for New Stationary Sources

UL SOLUTIONS (UL)

UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 1236	(2015; Reprint Feb 2021) UL Standard for Safety Battery Chargers for Charging Engine-Starter Batteries

1.2 RELATED MATERIALS

Section 26 13 13 METAL-CLAD SWITCHGEAR, Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, Section 26 05 48 SIESMIC PROTECTION FOR ELECTRICAL EQUIPMENT, 25 05 11.05 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS-GENERATOR/SWITCHGEAR SCADA and Section 26 08 00 APPARATUS INSPECTION AND TESTING apply to this section, except as modified herein.

1.3 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface". For this Section, any accessories requiring 600V or less station service electrical supply for function of the equipment (controls, actuators, battery chargers, heaters, etc.) shall be included in the CFCI Equipment Electrical Data submittal.

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office

that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Engine-Generator Set and Auxiliary Equipment; G, DO

Load Bank; G, DO

Auxiliary Systems; G, DO

Detailed Drawings; G, DO

SD-03 Product Data

Harmonic Requirements; G, DO

Engine-Generator Set Efficiencies; G, DO

Emissions; G, DO

filters; G, DO

special tools; G, RO

Engine-Generator Parameter Schedule; G, DO

Heat Exchanger; G, DO

Generator; G, DO

Manufacturer's Catalog

Load Bank; G, DO

Load Bank Connection Cabinet; G, DO

Site Welding; G, RO

Spare Parts; G, RO

Onsite Training; G, RO

Vibration-Isolation; G, DO

Posted Data and Instructions; G, RO

Instructions; G, RO

Experience

Field Engineer; G, RO

General Installation; G, RO

Exciter; G, DO

SD-05 Design Data

Performance Criteria; G, DO

Power Factor; G, DO

Heat Exchanger; G, DO

Time-Delay on Alarms; G, DO

Cooling System; G, DO

Vibration Isolation; G, DO

Battery Charger; G, DO

Capacity Calculations for Engine-Generator Set; G, DO

Brake Mean Effective Pressure (BMEP) Calculations; G, DO

Torsional Vibration Stress Analysis Computations; G, DO

Turbocharger Load Calculations; G, DO

SD-06 Test Reports

Performance Tests;; G, RO

Factory Inspection and Tests; G, RO

Factory Tests; G, RO

Onsite Inspection and Tests; G,RO

Acceptance Checks and Tests; G, RO

Functional Acceptance Tests; G, DO

Maintenance Procedures; G, RO

Operation and Maintenance Manuals; G, RO

Inspections; G, RO

Functional Acceptance Test Procedure; G, DO

SD-07 Certificates

Cooling System; G, RO

Vibration Isolation; G, RO

Prototype Test; G, RO

Reliability and Durability; G, RO

Fuel System Certification; G, RO

Start-Up Engineer; G, RO

Instructor's Qualification Resume; G, RO

Engine Emission Limits; G, RO

Current Balance

Materials and Equipment; G, RO

SD-09 Manufacturer's Field Reports

Engine Tests; G, RO

Generator Tests; G, RO

Assembled Engine-Generator Set Tests; G, RO

SD-10 Operation and Maintenance Data

Preliminary Assembled Operation and Maintenance Manuals; G, RO

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and the paragraph ASSEMBLED OPERATION AND MAINTENANCE MANUALS.

SD-11 Closeout Submittals

Posted Data and Instructions; G, RO

Training Plan; G, RO

Acceptance; G, DO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 QUALITY ASSURANCE

1.4.1 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, NEMA, etc., the design, fabrication and installation must also conform to the code.

1.4.2 Site Welding

Weld structural members in accordance with Section 05 05 23.16 STRUCTURAL WELDING. For all other welding, qualify procedures and welders in accordance with ASME BPVC SEC IX.

a. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1.

b. Submit a copy of qualifying procedures and a list of names and identification symbols of qualified welders and welding operators.

c. Submit a letter listing the welder qualifying procedures for each welder, complete with supporting data such as test procedures used, what was tested to, and a list of the names of all welders and their identification symbols.

d. Perform welder qualification tests for each welder whose qualifications are not in compliance with the referenced standards. Notify the Contracting Officer 24 hours in advance of qualification tests which must be performed at the work site, if practical.

e. The welder or welding operator must apply the personally assigned symbol near each weld made as a permanent record.

1.4.3 Vibration Limitation

Limit the maximum engine-generator set vibration in the horizontal, vertical, and axial directions to 6 mils (peak-peak RMS), with an overall velocity limit of 0.95 inches/second RMS, at rated speed for all loads through 110 percent of rated speed. The engine-generator set must be provided with vibration isolation in accordance with the manufacturer's standard recommendation. Where the vibration isolation system does not secure the base to the structure floor or unit foundation, provide seismic restraints in accordance with the seismic parameters specified.

1.4.4 Torsional Analysis

Submit torsional analysis including prototype testing or calculations which certify and demonstrate that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds, plus/minus 10 percent.

1.4.5 Performance Data

Submit vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor. Also submit a description of seismic qualification of the engine-generator mounting, base, and vibration isolation.

1.4.6 Seismic Requirements

Seismic requirements must be in accordance with UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT, 23 05 48.19 SEISMIC BRACING FOR HVAC and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT .

1.4.7 Experience

Each component manufacturer must have a minimum of 3 years' experience in the manufacture, assembly and sale of components used with stationary engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler must have a minimum of 3 years' experience in the manufacture, assembly and sale of stationary engine-generator sets for commercial and industrial use. Submit a statement showing and verifying these requirements.

1.4.8 Field Engineer

The engine-generator set manufacturer or assembler must furnish a qualified field engineer to supervise the complete installation of the

engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment. The field engineer must have attended the engine generator manufacturer's training courses on installation and operation and maintenance of engine generator sets. Submit a letter listing the qualifications, schools, formal training, and experience of the field engineer.

1.4.9 Detailed Drawings

Submit detailed drawings showing the following:

a. Base-mounted equipment, complete with base and attachments, including anchor bolt template and recommended clearances for maintenance and operation.

b. Starting system.

c. Fuel system.

d. Cooling system.

e. Exhaust system.

f. Electric wiring of relays, breakers, programmable controllers, and switches including single line and wiring diagrams.

g. Lubrication system, including piping, pumps, strainers, filters, heat exchangers for lube oil and turbocharger cooling, electric heater, controls and wiring.

h. Location, type, and description of vibration isolation devices for all applications.

i. The safety system, including wiring schematics.

j. One-line schematic and wiring diagrams of the generator, exciter, regulator, governor, and instrumentation.

k. Panel layouts.

l. Mounting and support for each panel and major piece of electrical equipment.

m. Engine-generator set rigging points and lifting instructions.

1.4.10 Auxiliary Systems Engine-Generator Set and Auxiliary Equipment Drawing Requirements

Submit drawings pertaining to the engine-generator set and auxiliary equipment, including but not limited to the following:

a. Certified outline, general arrangement (setting plan), and anchor bolt details. Show total weight and center of gravity of assembled equipment on the steel sub-base.

b. Detailed elementary, schematic wiring, and interconnection diagrams of the engine starting system, jacket coolant heating system, engine protective devices, engine alarm devices, engine speed governor

system, generator and excitation system, and other integral devices.

c. Detailed elementary, schematic wiring; and interconnection diagrams of the fuel system, starting battery system, engine-generator control panel, and remote alarm annunciator.

d. Dimensional drawings or catalog cuts of exhaust silencers, radiator, fuel day tanks, fuel oil cooler, valves and pumps, intake filters, vibration isolators, and other auxiliary equipment not integral with the engine-generator set.

1.4.11 Auxiliary Systems Drawing Requirements

Submit drawings showing floor plan arrangement of exhaust, air intake, fuel oil cooler, and jacket coolant water systems including arrangement of piping and pipe sizes.

1.4.12 Vibration Isolation System Certification

Submit certification from the manufacturer that the vibration isolation system will reduce the vibration to the limits specified in the paragraph VIBRATION ISOLATION.

1.4.13 Fuel System Certification

When the fuel system requires a fuel oil cooler as described in the paragraph FUEL OIL COOLER, submit certification from the engine manufacturer that the fuel system design is satisfactory.

1.5 DELIVERY, STORAGE, AND HANDLING

Properly protect materials and equipment, in accordance with the manufacturers recommended storage procedures,before, during, and after installation. Protect stored items from the weather and contamination. During installation, cap piping and similar openings to keep out dirt and other foreign matter.

Deliver equipment on pallets or blocking wrapped in heavy-duty plastic, sealed to protect parts and assemblies from moisture and dirt. Protect and prepare batteries for shipment as recommended by the battery manufacturer. Store auxiliary equipment at the site in covered enclosures, protected from atmospheric moisture, dirt, and ground water.

1.6 EXTRA MATERIALS

Provide two sets of special tools and two sets of filters required for maintenance. Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. One handset must be provided for each electronic governor when required to indicate and/or change governor response settings. Furnish 4 liters one gallon of identical paint used on engine-generator set in manufacturer's sealed container with each engine-generator set.

Wrenches and tools specifically designed and required to work on the new equipment, which are not commercially available as standard mechanic's tools, must be furnished to the Contracting Officer.

Provide proposed operating instructions for the engine-generator set and auxiliary equipment laminated between matte-surface thermoplastic sheets

and suitable for placement adjacent to corresponding equipment. After approval, install operating instructions where directed.

1.7 MAINTENANCE SERVICES

Submit the operation and maintenance manuals and have them approved prior to commencing onsite tests.

1.7.1 Operation Manual

Provide three copies of the manufacturers standard operation manual . Sections must be separated by heavy plastic dividers with tabs which identify the material in the section. Fold drawings with the title block visible, and placed in 8-1/2 by 11 inch plastic pockets with reinforced holes. The manual must include:

a. Step-by-step procedures for system startup, operation, and shutdown;

b. Drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems with their controls, alarms, and safety systems;

c. Procedures for interface and interaction with related systems to include, utility power and paralleling switchgear, automatic transfer switches, fire alarm/suppression systems, and load shedding systems .

1.7.2 Maintenance Manual

Provide three copies of the maintenance manual containing the information described below in 8-1/2 x 11 inch three-ring binders. Separate each section by a heavy plastic divider with tabs. Fold drawings with the title block visible, and placed in plastic pockets with reinforced holes. The manual must include:

a. Procedures for each routine maintenance item.Procedures for troubleshooting.Factory-service, take-down overhaul, and repair service manuals, with parts lists.

b. The manufacturer's recommended maintenance schedule.

c. A component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components.

d. A list of spare parts for each piece of equipment and a complete list of materials and supplies needed for operation.

1.7.3 Assembled Operation and Maintenance Manuals

The contents of the assembled operation and maintenance manuals must include the manufacturer's O&M information required by the paragraph SD-10, OPERATION AND MAINTENANCE DATA and the manufacturer's O&M information specified in Section 26 36 23 AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH.

a. Manuals must be in separate books or volumes, assembled and bound securely in durable, hard covered, water resistant binder, and indexed by major assembly and components in sequential order.

b. A table of contents (index) must be made part of the assembled O&M. The manual must be assembled in the order noted in table of contents.

c. The cover sheet or binder on each volume of the manuals must be identified and marked with the words, "Operation and Maintenance Manual."

1.8 SITE CONDITIONS

Protect the components of the engine-generator set, including cooling system components, pumps, fans, and similar auxiliaries when not operating and provide components capable of the specified outputs in the following environment:

a. Site Location: Buckley, CO

b. Site Elevation: 5,663 feet above mean sea level.

c. Ambient Temperatures:

(1) Maximum 99 degrees F dry bulb, 59 degrees F wet bulb.

(2) Minimum -8 degrees F dry bulb.

d. Seismic Zone: Zone C as defined by ICC IBC.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

a. All equipment specified within this section and Section 26 13 13 METAL-CLAD SWITCHGEAR, are to be provided by Cummins.

b. Provide and install each engine-generator set complete and totally functional, with all necessary ancillary equipment to include: air filtration; SCR System; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine-generator set must satisfy the requirements specified in the Engine-Generator Parameter Schedule. Submit certification that the engine-generator set and cooling system function properly in the ambient temperatures specified.

c. Provide each engine-generator set consisting of one engine, one generator, and one exciter mounted, assembled, and aligned on one base; and all other necessary ancillary equipment which may be mounted separately. Assemble sets having a capacity of 750 kW or smaller and attach to the base prior to shipping. Sets over 750 kW capacity may be shipped in sections. Provide set components that are environmentally suitable for the locations shown and that are the manufacturer's standard product offered in catalogs for commercial or industrial use. Provide a generator strip heater for moisture control when the generator is not operating. Identify any nonstandard products or components and the reason for their use.

2.1.1 Engine-Generator Parameter Schedule

Engine-Generator Set and Auxiliary Equipment Capacity Calculations for Engine-Generator Set

ENGINE-GENERATOR PARAMETER SCHEDULE	
Identificatio	Cummins "DQLE"
Electrical Characteristics	
Power Rating	Emergency Standby Gross bhp rating / Net brake power rating 2500 kW at 0.8 power factor, prior to derating
Governor Type	Type Make / Model Isochronous
Overload Capacity (Prime applications only)	110 percent of Service Load for 1 hour in 12 consecutive hours
Service Load	3125 kVA (maximum) 2000 kVA (continuous)
Motor Starting kVA (Max.)	3125 kVA
Power Factor	0.8 lagging
Engine-Genera Applications	parallel with other generators on an isolated bus
Voltage Regulation (No Load to Full Load)(Stand-a applications)	plus or minus 2 percent (maximum)
Voltage Bandwidth (steady state)	plus or minus 0.5 percent
Frequency	60 Hz
Voltage	13,200 volts
Phases	3 Phase, Wye
Minimum Generator Sub-transient Reactance	12 percent Sub-transient
Max Step Load Increase	75 percent of Service Load at 0.8 PF

ENGINE-GENERATOR PARAMETER SCHEDULE	
Transient Recovery Time with Step Load Increase (Voltage)	10 seconds
Transient Recovery	10 seconds
Time with Step Load Increase (Frequency)	10 seconds
Maximum Voltage Deviation with Step Load Increase	10 percent of rated voltage
Maximum Frequency Deviation with Step Load Increase	5 percent of rated frequency
Max Step Load Decrease (without shutdown)	100 percent of Service Load at 0.8 PF
Frequency Bandwidth (steady state)	plus or minus 0.035 percent
Frequency Regulation (droop) (No Load to Full Load)	3 percent (maximum)
Frequency Bandwidth (steady state)	plus or minus 0.035 percent

ENGINE-GENERATOR PARAMETER SCHEDULE	
Reactances	Synchronous reactance, Xd Transient reactance, X'd Sub-transient reactance, X"d Negative sequence reactance, X2 Zero sequence reactance, Xo
Installation Elevation	5,663 above sea level

Brake Mean Effective Pressure (BMEP) Calculations

Calculation must verify that the engine meets the specified maximum BMEP, as follows:

$$\text{BMEP psi} = \frac{(120{,}000 \times \text{bkW}) \times (792{,}000 \times \text{bhp})}{(\text{rpm} \times \text{cu. in.})}$$

Where:

bkW bhp = bkW' + bkW" bhp' + bhp"
bkW" bhp" is the Brake kW horsepower required by engine driven fan for cooling radiator or motor driven fan for cooling radiator.
bkW' bhp' = kW/GEN.EFF. kW/(GEN.EFF. times 0.746)
GEN.EFF. = Generator efficiency
cu. in. = Total engine piston displacement in cubic inches
rpm = Engine revolutions per minute
kW = Minimum power rating

Torsional Vibration Stress Analysis Computations

ENGINE-GENERATOR PARAMETER SCHEDULE
Torsional vibrational stresses in the crankshaft and generator shaft of assembled engine and driven generator must not exceed 5000 psi when engine is driving generator at rated speed while assembled unit is loaded to rated engine-generator set power. Computations must be based on a mathematical model of the assembled generator set provided or based on calculations using measured values from tests on a unit identical to the one provided. Calculations based on models of, or measured data from, the unassembled engine and generator will not be acceptable. Calculations must include: a. A description of the system relating information pertinent to analysis such as operating speed range and identification plate data. b. A mass elastic assembly drawing, showing the arrangement of the units in the generator set and dimensions of shafting, including minimum diameters (or section moduli) of shafting in the system. c. A labeled line diagram of the mass elastic system indicating values of masses, stiffness, equivalent lengths, and equivalent diameters including basic assumptions and definition of terms. d. Sample computations showing procedures used to obtain resulting stress values. e. Computations indicating assembled engine-generator speed of 1800 rpm with assembly loaded to rated generator power and the resulting computed critical torsional stress values in the assembled engine crankshaft and generator shaft.
Turbocharger Load Calculations
NOTE: When the engine-generator set installation includes field installed exhaust system (i.e., the engine-generator set is installed internal to a building in lieu of in a self-contained outdoor enclosure), include the following paragraph. When the proposed exhaust system layout is different from that shown on the contract drawings, submit calculations showing that the external loads from the exhaust system such as weight and thermal expansion do not exceed the engine manufacturer's maximum allowed forces and moments on the turbocharger.

2.1.2 Rated Output Capacity

Provide each engine-generator-set with power equal to the sum of service load plus the machine's efficiency loss and associated ancillary equipment loads. Rated output capacity must also consider engine and/or generator oversizing required to meet requirements in paragraph Engine-Generator Parameter Schedule.

The engine must meet the specified maximum BMEP requirements at rated speed as calculated in accordance with the calculations in the engine-generator parameter schedule. The engine capacity must be based on the following:

a. Engine burning diesel fuel conforming to ASTM D975, Grade 2-D with ULSD, and 40-48 cetane number, or at an ambient temperature of 85 degrees F. For stationary engines operated in the United States, diesel fuel requirements are found in 40 CFR 60 Subpart IIII.

b. Engine cooled by a radiator fan mechanically driven by the engine or remote with a motor driven fan.

c. Engine cooled by coolant mixture of water and ethylene glycol, 50 percent by volume of each.

2.1.2.1 Engine Emission Limits

Engine must be certified by the manufacturer to meet applicable EPA emission standards found in 40 CFR 60 Subpart IIII. In addition, engine must meet any applicable state or local emission requirements and have an emmission level of "Stationary EPA Tier 4 final" (ex: California SCAQMD).

2.1.3 Power Ratings

Power ratings must be in accordance with EGSA 101P.

2.1.4 Transient Response

The engine-generator set governor and voltage regulator must cause the engine-generator set to respond to the maximum step load changes such that output voltage and frequency recover to and stabilize within the operational bandwidth within the transient recovery time. The engine-generator set must respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

2.1.5 Reliability and Durability

Each standby engine-generator set must have both an engine and a generator capable of delivering the specified power on a standby basis with an anticipated mean time between overhauls of no less than 5,000 hours operating with a load factor of 70 percent. Cite two like engines and two like generators that have performed satisfactorily in a stationary power plant, independent and separate from the physical location of the manufacturer's and assembler's facilities, for standby without any failure to start, including all periodic exercise. Provide like engines and generators that have had no failures resulting in downtime for repairs in excess of 72 hours during two consecutive years of service. Provide engines that are the same model, speed, bore, stroke, number and configuration of cylinders, and rated output capacity. Provide generators that are the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.

Submit a reliability and durability certification letter from the manufacturer and assembler to prove that existing facilities are and have been successfully utilizing the same components proposed to meet this specification, in similar service. Certification may be based on components, i.e. engines used with different models of generators and

generators used with different engines, and does not exclude annual technological improvements made by a manufacturer in the basic standard-model component on which experience was obtained, provided parts interchangeability has not been substantially affected and the current standard model meets the performance requirements specified. Provide a list with the name of the installations, completion dates, and name and telephone number of a point of contact.

2.1.6 Parallel Operation

Configure each engine-generator set specified for parallel operation for automatic parallel operation. Each set must be capable of parallel operation with one or more sets on an isolated bus .

2.1.7 Load Sharing

Configure each engine-generator set specified for parallel operation to automatically load share with other sets by proportional loading. Proportional loading must load each set to within 5 percent of its fair share. A set's fair share is its nameplate-rated capacity times the total load, divided by the sum of all nameplate-rated capacities of on-line sets. Incorporate both the real and reactive components of the load.

2.1.8 Vibration Isolation

Provide an engine-generator set with a vibration isolation system in accordance with the manufacturer's standard recommendation. Submit vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor plus description of seismic qualification of the engine-generator mounting, base, and vibration isolation. Submit torsional analysis including prototype testing or and calculations which certify and demonstrate that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds, plus 10 percent. Design and qualify vibration isolation systems as an integral part of the base and mounting system in accordance with the seismic parameters specified. Where the vibration isolation system does not secure the base to the structure floor or unit foundation, provide seismic restraints in accordance with the seismic parameters specified.

2.1.9 Harmonic Requirements

Non-linear loads to be served by each engine-generator set are as indicated. The maximum linear load demand (kVA at PF) when non-linear loads will also be in use is as indicated.

2.1.10 Starting Time Requirements

Upon receipt of a signal to start, each engine generator set will start, reach rated frequency and voltage and be ready to assume load within the time specified. For standby sets used in emergency power applications, each engine generator set will start, reach rated frequency and voltage, and power will be supplied to the load terminals of the automatic transfer switch within the starting time specified.

2.2 NAMEPLATES

Provide the manufacturer's name, type or style, model or serial number and

rating on a plate secured to the equipment for each major component of this specification. Provide plates and tags sized so that inscription is readily legible to operating or maintenance personnel and securely mounted to or attached in proximity of their identified controls or equipment. Lettering must be normal block lettering, a minimum of 0.25 inch high. As a minimum, provide nameplates for:

Engines	Relays
Generators	Transformers (CT & PT)
Regulators	Day tanks
Pumps and pump motors	Governors
Generator Breaker	Air Starting System
Economizers	Heat exchangers (other than base mounted)

Where the following equipment is not provided as a standard component by the engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

Battery charger	Heaters
Switchboards	Exhaust mufflers
Switchgear	Silencers
Battery	Exciters

2.2.1 Materials

Construct ID plates and tags of 16 gage minimum thickness bronze or stainless steel sheet metal engraved or stamped with inscription. Construct plates and tags not exposed to the weather or high operational temperature of the engine of laminated plastic, 0.125 inch thick, matte white finish with black center core, with lettering accurately aligned and engraved into the core.

2.2.2 Control Devices and Operation Indicators

Provide ID plates or tags for control devices and operation indicators, including valves, off-on switches, visual alarm annunciators, gages and thermometers, that are required for operation and maintenance of provided mechanical systems. Plates or tags must be minimum of 0.5 inch high and 2 inches long and must indicate component system and component function.

2.2.3 Equipment

Provide ID plates of a minimum size of high and 5 inches long on provided equipment indicating the following information:

a. Manufacturer's name, address, type and model number, serial number, and certificate of compliance with applicable EPA mission standards;

b. Contract number and accepted date;

c. Capacity or size;

d. System in which installed; and

e. System which it controls.

2.3 SAFETY DEVICES

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices such that proper operation of the equipment is not impaired.

2.4 MATERIALS AND EQUIPMENT

Submit certification stating that where materials or equipment are specified to comply with requirements of UL, written proof of such compliance has been obtained. The label or listing of the specified agency, or a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency are acceptable as proof.

2.4.1 Circuit Breakers, Low Voltage

UL 489.

2.4.2 Filter Elements

Provide the manufacturer's standard fuel-oil, lubricating-oil, and combustion-air filter elements.

2.4.3 Instrument Transformers

NEMA/ANSI C12.11.

2.4.4 Pipe (Compressed Air, Coolant, and Exhaust)

See 33 52 40 - Fuel Systems Piping for Fuel and Lube Oil Piping Requirements

ASTM A53/A53M, or ASTM A106/A106M steel pipe. Pipe smaller than 2 inches must be Schedule 80. Pipe 2 inches and larger must be Schedule 40.

2.4.4.1 Flanges and Flanged Fittings

ASTM A181/A181M, Class 60, or ASME B16.5, Grade 1, Class 150.

2.4.4.2 Pipe Welding Fittings

ASTM A234/A234M, Grade WPB or WPC, Class 150 or ASME B16.11, 3000 lb.

2.4.4.3 Threaded Fittings

ASME B16.3, Class 150.

2.4.4.4 Valves

MSS SP-80, Class 150.

2.4.4.5 Gaskets

Manufacturer's standard.

2.4.5 Pipe Hangers

MSS SP-58.

2.4.6 Electric Motors

Provide electric motors that conform to the requirements of NEMA MG 1. Motors must have sealed ball bearings and a maximum speed of 1800 rpm. Motors used indoors must have drip-proof frames; enclose those that are used outside. Alternating current motors larger than 1/2 Hp must be of the squirrel-cage induction type for operation on 208 volts or higher, 60 Hz, and three-phase power. Alternating current motors 1/2 Hp or smaller, must be suitable for operation on 120 volts, 60 Hz, and single-phase power. Direct current motors must be suitable for operation on 125 volts.

2.4.7 Motor Controllers

Provide motor controllers and starters that conform to the requirements of NFPA 70 and NEMA ICS 2.

2.5 ENGINE

Each engine must operate on conforming to ASTM D975, must be designed for stationary applications and must be complete with ancillaries. The engine must be a standard production model shown in the manufacturer's catalog describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate complete specification compliance. The engine must be naturally aspirated, supercharged, or turbocharged. The engine must be 2- or 4-stroke-cycle and compression-ignition type. The engine must be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. The engine must have a minimum of two cylinders. Opposed-piston type engines must have more than four cylinders. Each block must have a coolant drain port. Equip each engine with an over-speed sensor.

ISO 3046. Diesel engines must be four-cycle naturally aspirated, or turbocharged, or turbocharged and intercooled; vertical in-line or vertical Vee type; designed for stationary service. Engines must be capable of immediate acceleration from rest to normal speed without intermediate idle/warm up period or pre-lubrication to provide essential electrical power. Two-cycle engines are not acceptable.

2.5.1 Sub-base Mounting

Mount each engine-generator set on a structural steel sub-base sized to support the engine, generator, and necessary accessories, auxiliaries and control equipment to produce a complete self-contained unit as standard with the manufacturer. Design the structural sub-base to properly support the equipment and maintain proper alignment of the engine-generator set in the specified seismic zone. In addition, provide sub-base with both

lifting rings and jacking pads properly located to facilitate shipping and installation of the unit. Factory align engine and generator on the sub-base and securely bolt into place in accordance with the manufacturer's standard practice. Crankshaft must have rigid coupling for connection to the generator.

2.5.2 Assembly

Completely shop assemble each engine-generator set on its structural steel sub-base. Paint entire unit with manufacturer's standard paints and colors. After factory tests and before shipping, thoroughly clean and retouch painting as necessary to provide complete protection.

2.5.3 Turbocharger

If required by the manufacturer to meet the engine-generator set rating, provide turbine type driven by exhaust gas from engine cylinders, and direct connected to the blower supplying air to the engine intake manifold.

2.5.4 Alternator

Alternator shall be Cummins Generator Technologies, model S9H1D-F4 with winding. 991, capable of accepting maximum 12294.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.

2.5.5 Intercooler

Provide manufacturer's standard intercooler for engine size specified.

2.5.6 Miscellaneous Engine Accessories

Provide the following engine accessories where the manufacturer's standard design permits:

a. Piping on engine to inlet and outlet connections, including nonstandard companion flanges.

b. Structural steel sub-base and vibration isolators, foundation bolts, nuts, and pipe sleeves.

c. Level jack screws or shims, as required.

d. Rails, chocks, and shims for installation of sub-base on the foundation.

e. Removable guard, around fan. Support guard, on engine sub-base, to suit manufacturer's standard.

2.5.7 Intercooler

Provide manufacturer's standard intercooler for engine size specified.

2.6 FUEL SYSTEM

Provide fuel system conforming to the requirements of NFPA 30 and NFPA 37 and containing the following elements. Refer to 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS for day tank requirements.

2.6.1 Main Pump

Provide engines with an engine driven pump. The pump must supply fuel at a minimum rate sufficient to provide the amount of fuel required to meet the performance indicated within the parameter schedule. Base the fuel flow rate on meeting the load requirements and all necessary recirculation.

The use of an additional pump to supply fuel was determined not to be needed based on head and NPSHr pump data from Cummins. If that data is no longer accurate and the Contractor determines an additional pump is needed to supply fuel to the onboard generator pump, the Contractor shall supply and install an auxiliary fuel pump to meet the flow and pressure requirements.

2.6.2 Fuel Filter

Provide a minimum of one full-flow fuel filter for each engine. The filter must be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. Mark the inlet and outlet connections of the filter.

Provide intake filter assemblies for each engine of the oil bath or dry type, as standard with the manufacturer. Filters must be capable of removing a minimum of 92 percent of dirt and abrasive 3 microns and larger from intake air. Size filters to suit engine requirements at 100 percent of rated full load. Design unit for field access for maintenance purposes.

2.6.3 Relief/Bypass Valve

Provide a relief/bypass valve to regulate pressure in the fuel supply line, return excess fuel to a return line and prevent the build-up of excessive pressure in the fuel system.

2.6.4 Fuel Supply System

Provide the fuel supply from the main storage of fuel to the day tank as specified in Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.6.5 Strainer

Duplex strainers must comply with 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT)

2.7 LUBRICATION

Provide engine with a separate lube-oil system conforming to NFPA 30 and NFPA 37. Pressurize each system by engine-driven pumps. Regulate system pressure as recommended by the engine manufacturer. Provide a pressure relief valve on the crankcase for closed systems. Vent the crankcase in accordance with the manufacturer's recommendation. Do not vent the crankcase to the engine exhaust system. Crankcase breathers, if provided on engines installed in buildings or enclosures, must be piped to vent to the outside. The system must be readily accessible for service such as draining, refilling, etc. Each system must permit addition of oil and have oil-level indication with the set operating. The system must utilize an oil cooler as recommended by the engine manufacturer.

2.7.1 Lube-Oil Filter

Provide one full-flow filter for each pump. The filter must be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. Mark inlet and outlet connections.

2.7.2 Lube-Oil Sensors

Equip each engine with lube-oil pressure sensors located downstream of the filters and provide signals for required indication and alarms. Submit two complete sets of filters, required for maintenance, supplied in a suitable storage box. Provide these filters in addition to filters replaced after testing.

2.7.3 Precirculation Pump

Provide a motor-driven precirculation pump powered by the station battery, complete with motor starter, if recommended by the engine manufacturer.

2.7.4 Crankcase Drain

Arrange for gravity draingage to a drain pipe near the generator,with no dissambly and without use of pumps, siphons, special tools, or appliances.

2.8 COOLING SYSTEM

Provide each engine with its own cooling system to operate automatically while its engine is running. The cooling system coolant must use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor temperature specified. The maximum temperature rise of the coolant across each engine must not exceed that recommended below. Submit a letter which certifies that the engine-generator set and cooling system function properly in the ambient temperature specified, stating the following values:

a. The maximum allowable inlet temperature of the coolant fluid.

b. The minimum allowable inlet temperature of the coolant fluid through the engine.

c. The maximum allowable temperature rise in the coolant fluid through the engine.

d. The minimum allowable inlet fuel temperature.

2.8.1 Coolant Pumps

Provide centrifugal coolant pumps. Each engine must have an engine-driven primary pump. Provide secondary pumps that are electric motor driven and have automatic controllers. Control raw-water circulating pump by manual-off-automatic controllers and must be engine driven.

2.8.2 Heat Exchanger

Provide heat exchanger with the size and capacity to limit the maximum allowable temperature rise in the coolant across the engine to that recommended and submitted for the maximum summer outdoor design temperature and site elevation. Submit manufacturer's data to quantify

heat rejected to the space with the engine generator set at rated capacity. Provide heat exchangers that are corrosion resistant, suitable for service in ambient conditions of application.

2.8.2.1 Fin-Tube-Type Heat Exchanger (Radiator)

Heat exchanger may be factory coated with corrosion resistant film, provided that corrective measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over sizing, or other compensating methods. Provide internal surfaces that are compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Provide heat exchangers that are pressure type incorporating a pressure valve, vacuum valve and a cap. Design caps for pressure relief prior to removal. Provide heat exchanger and cooling system that is capable of withstanding a minimum pressure of 7 psi and protect with a strong grille or screen guard. Provide heat exchanger with at least two tapped holes; equip one tapped hole with a drain cock, and plug the rest.

Provide for each engine-generator set, as standard with the manufacturer.

a. Design Conditions: Each radiator unit must have ample capacity to remove not less than the total Btu per hour of heat rejected by its respective engine at 100 percent full-rated load to the jacket water, fuel oil, and lubricating oil system, and intercooler. Radiator capacity must be rated at optimum temperature of coolant leaving the engine and intercooler as recommended by the engine manufacturer with an ambient dry bulb air temperature outside the enclosure of 99 degrees F maximum, and -8 degrees F minimum at the site elevation specified in the paragraph SITE CONDITIONS, and with the coolant mixture specified in the paragraph ENGINE CAPACITY. Pressure drop through the radiator must not exceed 6 psi when circulating the maximum required coolant flow. Radiator air velocity must be a maximum of 1500 feet per minute.

b. Engine Mounted Radiator Construction: Radiator fan must direct airflow from the engine outward through the radiator. Fan must be V-belt driven directly from the engine crankshaft. Radiator fan must have sufficient capacity to meet design conditions against a static restriction of 0.5 inch of water. Fan static capacity must be adjusted to suit the ductwork furnished. Cooling section must have a tube and fin-type core consisting of copper or copper base alloy tubes with nonferrous fins. Select engine-driven fans for quiet vibration-free operation. Make provision for coolant expansion either by self-contained expansion tanks or separately mounted expansion tanks, as standard with the manufacturer. Provide suitable guards for each fan and drive.

c. Coolant solution must be a mixture of clean water and ethylene glycol, 50 percent by volume each. Provide an anti-freeze solution tester suitable for the mixture.

Field installed jacket coolant water piping must conform to the following:

a. Piping: Provide seamless steel pipe, Schedule 40, conforming to ASTM A53/A53M, Grade A.

b. Fittings and Flanges: Fittings, 1 1/2 inches or smaller, must be malleable iron conforming to ASME B16.3 for Class 300 threaded type.

Fittings, 2 inches and larger, must be steel butt welding conforming to ASME B16.9. Utilize either ASME B16.1 or Class A of ASTM A126 for Class 125 cast-iron flanged fittings. Flanges must be Class 150 slip-on forged steel welding flanges in accordance with ASME B16.5, with material in accordance with ASTM A181/A181M, Grade I. Provide flat face flanges for connecting to Class 125 standard cast-iron valves, fittings, and equipment connections.

c. Valves

(1) Gate Valves: For valves, 1 1/2 inches and smaller, provide double disk, rising stem, inside screw, union bonnet type, Class 125 bronze material conforming to MSS SP-80. For valves, 2 inches and larger, provide double-disk, parallel seat type, hydraulic-rated, Class 125, outside screw and yoke type with flanged ends and bronze trim conforming to MSS SP-70. Provide stem packing of material compatible with the system coolant.

(2) Globe Valves: For valves, 1 1/2 inches and smaller, provide rising stem, inside screw, union bonnet type, Class 125 bronze valves conforming to MSS SP-80. For valves, 2 inches and larger, provide Class 125 cast iron, flanged ends, bronze trim globe valves conforming to MSS SP-85. Valves must have renewable composition or cast iron discs compatible with the system coolant.

(3) Check Valves: MSS SP-71 or MSS SP-80, swing check type.

d. Hangers and Supports: MSS SP-58.

e. Piping Sleeves: Provide where piping passes through masonry or concrete walls, floors, roofs, and partitions. Place sleeves during construction. Unless indicated otherwise, pipe sleeves must comply with following requirements: Sleeves in outside walls below and above grade, in floor, or in roof slabs, must be standard weight zinc coated steel pipe. Sleeves in partitions must be zinc coated sheet steel having a nominal weight of not less than 0.90 pound per square foot. Space between piping insulation and the sleeve must be not less than 0.25 inch. Sleeves must be held securely in proper position and location during construction. Sleeves must be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs must extend 2 inches above the finished floor. Space between the pipe and the sleeve must be firmly packed with insulation and caulked at both ends of the sleeve with plastic waterproof cement.

2.8.2.2 Shell and U-Tube Type Heat Exchanger

Provide multiple pass shell, U-tube type heat exchanger. Exchanger must operate with low temperature water in the shell and high temperature water in the tubes. Provide exchangers that are constructed in accordance with ASME BPVC SEC VIII D1 and certified with ASME stamp secured to the unit. Provide U-tube bundles that are completely removable for cleaning and tube replacement and free to expand with the shell. Construct shells of seamless steel pipe or welded steel. Tubes must be cupronickel or inhibited admiralty, constructed in accordance with ASTM B395/B395M, suitable for the temperatures and pressures specified. Tubes less than 3/4 inch unless otherwise indicated are not acceptable. Design shell side and tube side for 150 psig working pressure and factory tested at 300 psig. Locate high and low temperature water and pressure relief connections in accordance with the manufacturers standard practice. Water connections

larger than 3 inches must be ASME Class 150 flanged. Water pressure loss through clean tubes must be as recommended by the engine manufacturer. Minimum water velocity through tubes must be 1 fps and assure turbulent flow. Provide one or more pressure relief valves for each heat exchanger in accordance with ASME BPVC SEC VIII D1. The aggregate relieving capacity of the relief valves must be not less than that required by the above code. Install discharge from the valves indicated. Install the relief valves on the heat exchanger shell. Install a drain connection with 3/4 inch hose bib at the lowest point in the system near the heat exchanger. Install additional drain connection with threaded cap or plug wherever required for thorough draining of the system.

2.8.3 Expansion Tank

The cooling system must include an air expansion tank which will accommodate the expanded water of the system generated within the normal operating temperature range, limiting the pressure increase at all components in the system to the maximum allowable pressure at those components. The tank must be suitable for operating temperature of 250 degrees F and a working pressure of 125 psi. Provide welded steel tank , tested and stamped in accordance with ASME BPVC SEC VIII D1 for the stated working pressure. Do not use a bladder type tank. Support the tank by steel legs or bases for vertical or steel saddles for horizontal installation.

2.8.4 Thermostatic Control Valve

Provide a modulating type, thermostatic control valve in the coolant system to maintain the coolant temperature range submitted in paragraph SUBMITTALS.

2.8.5 Ductwork

Provide ductwork as specified in Section Section 23 30 00 HVAC AIR DISTRIBUTION except use a flexible connection to connect the duct to the engine radiator. Material for the connection must be wire-reinforced glass. Provide airtight connection.

2.8.6 Temperature Sensors

Equip each engine with coolant temperature sensors. Provide temperature sensors with signals for pre-high and high indication and alarms.

2.9 AIR INTAKE EQUIPMENT

Locate filters and silencers in locations that are convenient for servicing. Provide high-frequency filter type silencers and locate in the air intake system as recommended by the engine manufacturer. Provide silencer to reduce the noise level at the air intake so that the indicated pressure levels specified in paragraph SOUND LIMITATIONS will not be exceeded. A combined filter-silencer unit meeting requirements for the separate filter and silencer items may be provided. Provide rubber expansion elements in air-intake lines.

Provide intake filter assemblies for each engine of the oil bath or dry type, as standard with the manufacturer. Filters must be capable of removing a minimum of 92 percent of dirt and abrasive 3 microns and larger from intake air. Size filters to suit engine requirements at 100 percent of rated full load. Design unit for field access for maintenance purposes.

2.10 EXHAUST SYSTEM

Provide a separate and complete system for each engine. Support piping to minimize vibration. Where a V-type engine is provided, use a V-type connector, with necessary flexible sections and hardware, to connect the engine exhaust outlets.

2.10.1 Flexible Sections and Expansion Joints

Provide a flexible section at each engine and an expansion joint at each muffler. Provide flexible sections and expansion joints that have flanged connections. Provide flexible sections made of convoluted seamless tube without joints or packing. Provide bellows type expansion joints. Provide stainless steel expansion and flexible elements suitable for engine exhaust gas at the maximum exhaust temperature that is specified by the engine manufacturer. Provide expansion and flexible elements that are capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

2.10.2 Exhaust Muffler

Provide a chamber type exhaust muffler. Provide welded steel muffler designed for inside horizontal mounting. Provide eyebolts, lugs, flanges, or other items as necessary for support in the location and position indicated. Do not exceed the engine manufacturer's recommended pressure drop. Outside mufflers must be zinc coated or painted with high temperature 400 degrees F resisting paint. The muffler and exhaust piping together must reduce the noise level to less than the maximum acceptable level listed for sound limitations in paragraph SOUND LIMITATIONS. Provide muffler with a drain valve, nipple, and cap at the low-point of the muffler.

A critical class silencer must be provided for each engine which will reduce the exhaust sound spectrum by the following listed values at a 75 foot radius from the outlet, with generator set loaded to rated capacity and clear weather. Inlet and outlet connections must be flanged.

Octave Band Center Frequency (Hertz)								
Minimum Silencer Attenuation Decibels	63	125	250	500	1000	2000	4000	8000
Critical Class	15	32	37	36	30	36	37	37

2.10.3 Exhaust Piping

Slope horizontal sections of exhaust piping downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction must be long radius. Insulate exhaust piping, mufflers and silencers installed inside any building in accordance with paragraph THERMAL INSULATION and covered to protect personnel. Provide vertical exhaust piping with a hinged, gravity-operated, self-closing, rain cover.

Field installed exhaust piping must conform to the following:

a. Exhaust Piping: Provide flanges for connections to engines, exhaust mufflers, and flexible connections. Provide steel pipe conforming to

ASTM A53/A53M for each engine complete with necessary fittings, flanges, gaskets, bolts, and nuts. Exhaust piping must be Schedule 40 pipe for 12 inches and smaller, standard weight for sizes 14 inches through 24 inches, and 0.25 inch wall thickness for sizes larger than 24 inches. Flanges must be Class 150 slip-on forged steel welding flanges in accordance with ASME B16.5, with material in accordance with ASTM A181/A181M, Grade I. Fittings must be butt welding conforming to ASTM A234/A234M, with wall thickness same as adjoining piping. Fittings must be of same material and wall thickness as pipe. Built-up miter welded fittings may be used. Miter angles of each individual section must not exceed 22.5 degrees total and not more than 11.25 degrees relative to the axis of the pipe at any one cut. Gaskets for exhaust piping must be of high temperature asbestos-free material suitable for the service and must be ASME B16.21, composition ring, 0.0625 inch thick. Bolting material for exhaust flanges must be alloy-steel bolt-studs conforming to ASTM A193/A193M, Grade B7 bolts and alloy-steel nuts conforming to ASTM A194/A194M, Grade 7. Bolts must be of sufficient length to obtain full bearing on the nuts and must project not more than two full threads beyond the nut. Provide stainless steel counterbalance type rain caps at termination of each exhaust pipe.

b. Expansion (Flexible) Joints: Provide sections of multiple corrugated stainless steel expansion joints with liners in the engine exhaust piping for each engine to absorb expansion strains and vibration transmitted to the piping. Flexible joints must be suitable for operation at 200 degrees F above normal exhaust gas temperature at 100 percent load, 10,000 cycles, minimum. Joints must be flanged and located between engine exhaust manifold and exhaust piping, must be the same size as exhaust piping size, and must be designed and constructed for engine exhaust service.

c. Hangers and Supports: MSS SP-58.

d. Piping Sleeves: Provide where piping passes through masonry or concrete walls, floors, roofs, and partitions. Sleeves must be placed during construction. Unless indicated otherwise, pipe sleeves must comply with following requirements: sleeves in outside walls below and above grade, in floor, or in roof slabs, must be standard weight zinc coated steel pipe. Sleeves in partitions must be zinc coated sheet steel having a nominal weight of not less than 0.90 pound per square foot. Space between piping insulation and the sleeve must not be less than 0.25 inch. Sleeves must be held securely in proper position and location during construction. Sleeves must be sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs must extend 2 inches above the finished floor. Space between the pipe and the sleeve must be firmly packed with insulation and caulked at both ends of the sleeve with plastic waterproof cement.

e. Piping Insulation: Provide exhaust piping insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.11 CATALYTIC REDUCTION SYSTEMS FOR ENGINE EXHAUST

The Selective Catalytic Reduction (SCR) system must be designed to meet or exceed exhaust emissions compliance levels up to U.S. EPA Tier 4 Final standards. The system must ensure compliance with the required emissions limits for the power rating of the engine operating at 100% load. The SCR

system must be capable of reducing NOx emissions by a minimum of 90% while maintaining a maximum ammonia slip of 10 PPM @ 15% O? during operation. Particulate matter (PM) reduction must be at least 85% based on a 5-mode test, with additional capabilities of 80% CO reduction and up to 80% VOC reduction, depending on operating temperature.

The system must be designed to handle an exhaust flow rate of 19,276 cfm at a design temperature of 899°F, with an allowable exhaust temperature range of 572°F - 977°F. The system's exhaust pressure drop, including the housing, catalyst, mixing section, and any transitions, must not exceed 18 inches of water column (clean). The catalyst volume must be 40 ft^3, with a system dosing capacity of 60 L/hr and an estimated reactant consumption of 13 gal/hr (49 L/hr) per engine.

Piping and structural supports must be designed to minimize vibration and stress. The system must be fully compatible with the Cummins DQLE generator but must not be restricted to a specific manufacturer. The reducing agent must be a 32.5% urea-based Diesel Exhaust Fluid (DEF), and the system must include all necessary components for metering, injection, and monitoring to ensure reliable and efficient operation.

The physical installation of the SCR system must be constrained to ensure unobstructed access to the designated drive lane. The system must not protrude more than 5 feet plan south of the engine, thereby preventing any blockage of the drive lane. The drive lane must remain a continuous, unobstructed path from the roll-up garage door on the plan west exterior wall to the roll-up garage door on the middle wall separating Generator Bay A and Generator Bay B. The system layout must be coordinated with structural, mechanical, and access requirements to maintain operational and service clearances.

2.11.1 Catalytic Reduction System

The engine(s) shall be furnished with a catalytic reduction system to reduce engine exhaust emissions to meet specified compliance levels up to Tier 4 Final. The system shall meet the limits required for the power rating of the engine, at 100% load.

Catalytic Rduction System must conform to the following:

a. Exhaust pressure drop through the complete emission control system including housing(s), catalyst, mixing section and any transitions shall not exceed 18 inches water column (Clean).

b. The capabilities of a fully outfitted system shall be:

    1. 85%+ PM reduction (5 mode test)

    2. 90% NOx reduction

    3. 80%+ CO reduction

    4. Up to 80% VOC reduction (temperature dependent)

c. The reducing agent metering and control system shall be capable of ensuring that the maximum ammonia slip to atmosphere from the SCR system shall not exceed 10 PPMV @ 15% O2 while the system is in operation.

2.11.2 System Components

The installation of the exhaust after treatment system shall include all material and parts required for the system. The system shall be designed to contain a complete DPF/DOC/SCR integrated catalyst reactor housing with racks/tracks for DPF, SCR, and DOC catalyst material to meet PM, NOx, CO, and VOC performance specifications.

The housing shall be a rigid structure, which will not warp or deform significantly during normal operation. The housing must be complete with inlet and outlet transition sections designed for bolting to the exhaust gas ductwork. The reactor shall be provided with an integrated mounting base so that the hosing itself is isolated from vibration and can accommodate thermal expansion. Four (4) lifting lugs, two (2) on each side shall be provided for ease of handling

System Components must conform to the following:

a. Shall be equipped with access doors to the catalyst. The doors shall be easily removed without the assistance of lifting equipment and be on top or the side of the housing and shall provide access to each layer of catalyst without removal of any adjacent catalyst.

b. Shall be constructed of carbon steel with a high-temperature black coating.

c. Shall be provided with internal catalyst support structure and perforated plates or other flow dispersion method.

d. Shall provide instrumentation ports for differential pressure and temperature upstream and downstream of the catalyst beds.

e. The Urea Mixing Section should be fully integrated within the housing and should be of adequate length to achieve proper mixing and hydrolysis. The Mixing Section shall contain the necessary static mixers, flow straighteners, and other devices as specified by the Manufacturer to achieve proper urea hydrolysis and mixing.

f. Passive Diesel Particulate Filter (DPF) modules:

1. The filter media shall be extruded, porous mullite material blocks with square monolithic channels (honeycomb structure). Each channel shall be plugged on one end only, with adjacent channels plugged on opposite ends, such that flow must pass through the walls between adjacent channels.

2. The blocks shall have a square cross section, so that they can be stacked easily. They shall be approximately 150 mm x 150 mm in cross section and 300 mm in depth.

3. The blocks shall be coated with a catalyst material to lower the exhaust temperature required for regeneration to 500°F/260°C.

4. Particulate regeneration shall not be dependent on NOx:PM or NO:NO2 ratios in the exhaust..

g. Diesel Oxidation Catalyst (DOC):

1. The System Manufacturer shall also manufacturer the DOC. The DOC substrate shall consist of alternating corrugated layers of stainless steel alloy foil that is layered, stacked and electronically resistant welded. The channels shall provide a high surface area and multiple turbulent zones without causing excessive exhaust back pressure.

2. The catalytically active materials shall be a precious metal coating on the DOC that is made from a combination of Platinum Group Metals selected by the manufacturer.

3. A single high temperature fiberglass gasket shall be wrapped around the element to seal it within the housing. The top surface of the sealing plate shall be sealed against the door when it is installed.

4. The catalyst substrate and metal foil shall not sinter or degrade when exposed to exhaust inlet temperature up to 1,250°F (677 °C).

5. To facilitate maintenance, the catalyst(s) must be removable via bolt-on access doors.

h. SCR Catalysts:

1. SCR Catalyst shall be extruded, ceramic blocks with square monolithic channels (honeycomb type). The catalyst material shall be mixed into the substrate prior to extrusion. The catalyst material composition shall be tungsten, vanadium, titanium and other base metals. The catalyst shall have a proven track record in similar applications.

2. Shall be shop assembled with a high temperature fiberglass gasket material. The modules should be approximately 150mm x 150mm in cross section and 150, 300 or 450mm in depth for ease of field installation and removal from the reactor housing.

3. Shall have a continuous operating range of 572°F to 977°F / 300°C to 530°C.

4. Shall be designed to minimize SO2 to SO3 conversion rate.

i. Urea Injection Lance:

1. The urea injection lance shall be constructed of 304 Stainless Steel. It shall be installed via a flanged port on the Catalyst housing. Lance shall be a 2-phase type using compressed air to atomize the urea solution as well as to purge and cool the lance.

2. Injection lance shall be easily removed for maintenance and shall only require standard hand tools.

j. SCR Open Loop Control Unit:

1. Urea injection shall be determined by utilizing site specific urea flow levels established at specific load levels. Manufacturer's Technicians shall develop the injection map during commissioning.

2. The system shall monitor the current urea flowrate and compare

it to the target flowrate given the current engine load. It shall automatically adjust the control valve or pump speed (as appropriate) to maintain the desired urea flow rate.

3. Control system shall use an analog (4-20 mA DC) engine load signal (supplied from the Gen-Set Controls) to set the base urea injection rate.

4. Data shall be available to the operator via an integrated touch panel. Remote monitoring and control shall be available via Ethernet connection to the controller.

5. All settings shall be adjustable from the integrated touch panel.

6. All operating parameters shall be available via Modbus TCP for connection to Owners building automation system.

7. Controller shall allow for ethernet or serial settings to be changed via on-screen menus.

8. The system shall provide basic on-screen troubleshooting guides.

9. Data Logging. The Controller shall log operating parameters every 5 minutes and store up to 3 months of continuous data. At a minimum record the following items:

a.	Date
b.	Time
c.	Engine Load (%)
d.	Dosing Valve Position (%)
e.	Reactant flow (l/hr or gal/hr)
f.	Temperature after converter (F or C)
g.	Temperature entering Converter (F or C)
h.	Pressure drop across converter (inches water or mbar)

10. The system shall automatically stop and re-start under the following conditions:

a. SCR Catalyst bed temperature less than 570 °F/300?C.

b. Engine shutdown.

11. Control Unit enclosure shall be NEMA 1 rated for indoor installation with standard control operating temperature up to 122°F/50?C ambient temperature. Coordinate with Packager or Installer on specific site requirement.

12. The Control Unit shall by physically separate from the Dosing

Control; no urea lines shall be allowed to enter the Control Unit.

13. All settings shall be adjustable from the integrated touch panel.

k. Urea Booster Pump:

1. Provide skid mounted urea pump with required pressure regulator, relief valve, pulsation dampener, etc., as specified by the manufacturer. Pump shall be controlled by the SCR Control Unit. Provide one pump per system.

2. Pump skid shall be suitable for indoor ambient temperatures down to 50° F/2°C. Pre-plumb all urea supply and return lines to bulkhead fittings on the enclosure.

l. Air Compressor:

1. Provide skid mounted air compressor to supply injection/purge air as required for proper operation. Air compressor shall be oil-free rotary vane type and shall not require lubricators.

2. Compressor skid shall be suitable for indoor installation in ambient temperatures up to 110° F.

m. Urea Storage Tank and Accessories:

1. Urea day tank shall be free standing, horizontal, single wall cross-linked polyethylene tank suitable for storage of liquids up to 1.9 specific gravity.

2. Tanks shall have inspection manways sized by the tank manufacturer.

3. Day tanks shall have fittings for urea supply to pump skid, urea return from pump, level sensor, urea quality sensor, temperature sensor, and urea fill. The urea fill shall have a drop tube to the bottom of the tank.

4. Urea tanks shall be of sufficient capacity for 168 hours of SCR operation at 66% engine load OR have a sum of 3,200 gallons.

2.12 PYROMETER

Provide a pyrometer, and thermocouple with calibrated leads to show the temperature of the combined exhaust. For a supercharged engine, provide additional points, thermocouples and leads to show the temperature in the turbocharger exhaust gas outlet and combustion air discharge passages. Graduated scale length less than 6 inches is not acceptable. Provide double pole selector switch with an "off" position, one set of points for each thermocouple, and suitable indicating dial. Calibrate the pyrometer, thermocouples, leads and compensating devices to show true exhaust temperature within plus or minus 1 percent above the highest temperature encountered at 110 percent load conditions.

2.13 EMISSIONS

The finished installation must comply with Federal, state, and local regulations and restrictions regarding the limits of emissions, as listed

here: Stationary EPA Tier 4 Final. Submit certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local regulations and restrictions specified. At a minimum this certification must include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and for hazardous air pollutants (HAPs).

2.14 STARTING SYSTEM

Provide starting system for standby engine generator sets used in emergency applications in accordance with NFPA 110and as follows.

2.14.1 Controls

Provide an engine control switch with functions including: run/start (manual), off/reset, and, automatic mode. Provide start-stop logic for adjustable cycle cranking and cool-down operation. Arrange the logic for manual starting and fully automatic starting in accordance with paragraph AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION. Provide electrical starting systems with an adjustable cranking limit device to limit cranking periods from 1 second up to the maximum duration.

2.14.2 Capacity

Provide starting system with sufficient capacity, at the maximum indoor summer temperature specified to crank the engine without damage or overheating. The system must provide a minimum of three cranking periods with 15 second intervals between cranks. Each cranking period must have a maximum duration of 15 seconds. Starting must be accomplished using an adequately sized dc starter system with a positive shift solenoid to engage the starter motor and to crank the engine continuously for 60 seconds without overheating.

2.14.3 Electrical Starting

Manufacturers recommended dc system, utilizing a negative circuit ground. Starting motors must be in accordance with SAE ARP892.

2.14.3.1 Battery

Provide a starting battery system including the battery, battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering and relaying. Provide battery in accordance with SAE J537. Size critical system components (rack, protection, etc.) to withstand the seismic acceleration forces specified. Provide lead-acid battery with sufficient capacity, at the minimum indoor and maximum indoor temperature specified, to provide the specified cranking periods. Valve-regulated lead-acid batteries are not acceptable.

Provide maintenance free, sealed, lead-acid, SAE Type D engine starting batteries. Battery configuration must be two parallel sets of two 12-volt batteries. Batteries must have sufficient capacity to provide 60 seconds of continuous cranking of the engine in an ambient temperature of 35 degrees F.

2.14.3.2 Battery Charger

Provide a current-limiting battery charger, conforming to UL 1236, that automatically recharges the batteries. Submit battery charger sizing

calculations. The charger must be capable of an equalize charging rate for recharging fully depleted batteries within 24 hours and a floating charge rate for maintaining the batteries at fully charged condition. Provide an ammeter to indicate charging rate. Provide a voltmeter to indicate charging voltage. Provide a timer for the equalize charging-rate setting. A battery is considered to be fully depleted when the output voltage falls to a value which will not operate the engine generator set and its components.

Provide 120 volt ac, enclosed, automatic equalizing, dual-rate, solid-state, constant voltage type battery charger with automatic ac line compensation. DC output must be voltage regulated and current limited. Charger must have two ranges, float and equalize, and must provide continuous taper charging. The charger must have a continuous output rating of not less than 10 amperes and must be sized to recharge the engine starting batteries in a minimum of 8 hours while providing the control power needs of the engine-generator set. Enclosure must be NEMA ICS 6, Type 1 . The following accessories must be included:

a. DC ammeter

b. DC voltmeter

c. Equalize light

d. AC on light

e. Low voltage light

f. High voltage light

g. Equalize test button/switch

h. AC circuit breaker

i. Low dc voltage alarm relay

j. High dc voltage alarm relay

k. Current failure relay

l. AC power failure relay

2.14.4 Starting Aids

Provide one or more of other following methods to assist engine starting.

2.14.4.1 Glow Plugs

Design glow plugs to provide sufficient heat for combustion of fuel within the cylinders to guarantee starting at an ambient temperature of -25 degrees F.

2.14.4.2 Jacket-Coolant Heaters

Mount a thermostatically controlled electric heater in the engine coolant jacketing to automatically maintain the coolant within plus or minus 3 degrees F of the control temperature. The heater must operate independently of engine operation so that starting times are minimized.

Power for the heaters must be 208V volts ac. Include necessary equipment, piping, controls, wiring, and accessories.

2.14.4.2.1 Standby Rated Sets

The control temperature must be the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

2.14.5 Exerciser

Provide exerciser in accordance with Section 26 36 23 AUTOMATIC TRANSFER SWITCH AND BY-PASS/ISOLATION SWITCH.

2.15 GOVERNOR

Provide a forward acting type engine speed governor system. Steady-state frequency band and frequency regulation (droop) must be in accordance with the operating limit values of the performance class specified in the paragraph PERFORMANCE CLASS.

Provide engine with a governor which maintains the frequency within a bandwidth of the rated frequency, over a steady-state load range of zero to 100 percent of rated output capacity. Configure the governor for safe manual adjustment of the speed/frequency during operation of the engine-generator set, without special tools, from 90 to 110 percent of the rated speed/frequency, over a steady state load range of 0 to 100 percent or rated capacity. Submit two complete sets of special tools required for maintenance (except for electronic governor handset). Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. Provide a suitable tool box for tools. Provide one handset for each electronic governor when required to indicate and/or change governor response settings. Maintain the midpoint of the frequency bandwidth at the same value for steady-state loads over the range of zero to 100 percent of rated output capacity for isochronous governors.

2.16 GENERATOR

Provide synchronous type, one or two bearing, generator conforming to the performance criteria in NEMA MG 1, equipped with winding terminal housings in accordance with NEMA MG 1, equipped with an amortisseur winding, and directly connected to the engine. Submit calculations of the engine and generator output power capability, including efficiency and parasitic load data. Provide Class F insulation.

a. Select NEMA MG 1, Part 16, standby duty, and temperature rise of 125 degrees C for engine-generator sets which are expected to operate for less than 300 hours per year. Select NEMA MG 1, Part 22, continuous duty, and temperature rise of 105 degrees C for engine-generator sets expected to operate 300 hours or greater per year or rated 300 kW and above.

b. For applications requiring high SCR loading or in harsh environments laden with salts and chemicals, select vacuum pressure impregnation (VPI) insulated coils. When engine-generator sets are rated 800 kW and larger, also select form wound coils.

c. Provide salient-pole type, ac, brushless-excited, revolving field,

air-cooled, self-ventilated, drip-proof guarded, coupled type, synchronous generator conforming to NEMA MG 1, and IEEE C50.12. Generator must be rated for standby duty at 100 percent of the power rating of the engine-generator set as specified in paragraph ENGINE-GENERATOR SET RATINGS AND PERFORMANCE. Temperature rise of each of the various parts of the generator must not exceed 125 degrees C as measured by resistance, based on a maximum ambient temperature of 40 degrees C. Winding insulation must be Class H.

d. Stator: Stator windings must be 2/3 pitch design, 10-12 lead re-connectable .

e. Rotor: The rotor must have connected amortisseur windings.

f. Grounding: Provide non-corrosive steel grounding pads located at two opposite mounting legs.

g. Filters: Provide manufacturer's standard generator cooling air filter assembly.

h. Design generator to protect against mechanical, electrical and thermal damage due to vibration, 25 percent overspeeds, or voltages and temperatures at a rated output capacity of 110 percent for prime applications and 100 percent for standby applications.

i. Provide generator ancillary equipment meeting the short circuit requirements of NEMA MG 1. Select drip-proof guarded option for generators without weatherproof enclosures.

j. Submit manufacturer's standard data for each generator (prototype data at the specified rating or above is acceptable), listing the following information:

(1) Direct-Axis sub-transient reactance (per unit).

(2) The generator kW rating and short circuit current capacity (both symmetric and asymmetric).

2.16.1 Current Balance

At 100 percent rated output capacity, and load impedance equal for each of the 3 phases, the permissible current difference between any 2 phases must not exceed 2 percent of the largest current on either of the 2 phases. Submit certification stating that the flywheel has been statically and dynamically balanced and is capable of being rotated at 125 percent of rated speed without vibration or damage.

2.16.2 Voltage Balance

At any balanced load between 75 and 100 percent of rated output capacity, the difference in line-to-neutral voltage among the 3 phases must not exceed 1 percent of the average line-to-neutral voltage. For a single phase load condition, consisting of 25 percent load at unity power factor placed between any phase and neutral with no load on the other 2 phases, the maximum simultaneous difference in line-to-neutral voltage between the phases must not exceed 3 percent of rated line to neutral voltage. The single-phase load requirement must be valid utilizing normal exciter and regulator control. The interpretation of the 25 percent load for single phase load conditions means 25 percent of rated current at rated phase

voltage and unity power factor.

2.16.3 Waveform

The deviation factor of the line-to-line voltage at zero load and at balanced rated output capacity must not exceed 10 percent. The RMS of all harmonics must be less than 5.0 percent and that of any one harmonic less than 3.0 percent of the fundamental at rated output capacity. Design and configure engine-generator to meet the total harmonic distortion limits of IEEE 519.

2.17 EXCITER

Provide brushless generator exciter. Provide semiconductor rectifiers that have a minimum safety factor of 300 percent for peak inverse voltage and forward current ratings for all operating conditions, including 110 percent generator output at 104 degrees F ambient. The exciter and regulator in combination must maintain generator-output voltage within the limits specified.

Provide a brushless excitation system consisting of an exciter and rotating rectifier assembly , and permanent magnet generator integral with the generator and a voltage regulator. Insulation class for parts integral with the generator must be as specified in paragraph GENERATOR. System must provide a minimum short circuit of 300 percent rated engine-generator set current for at least 10 seconds. Steady state voltage regulation must be in accordance with the operating limit values of the performance class specified in the paragraph PERFORMANCE CLASS.

a. Exciter and Rotating Rectifier Assembly: Rectifiers must be provided with surge voltage protection.

b. Permanent Magnet Generator: Provide a voltage spike suppression device for permanent magnet generator (PMG) excitation systems.

c. Voltage Regulator: Voltage regulator must be solid state or digital, automatic, three-phase sensing, volts per hertz type regulator. Regulator must receive its input power from a PMG. Voltage variation for any 40 degree C change over the operating temperature range must be less than plus or minus 1.0 percent. Operating temperature must be minus 40 degree C to plus 70 degree C. Voltage adjust range must be plus to minus 5.0 percent of nominal. Inherent regulator features must include over excitation shutdown.

2.17.1 Electromagnetic Interference (EMI) Suppression

Provide as an integral part of the generator and excitation system, EMI suppression complying with MIL-STD-461.

2.18 LOAD BANK

A permanent, pad mounted resistive load bank shall be provided and installed. The load bank shall be sized no less than the full rated load of the largest single generator unit at the generators rated output voltage.

a. Dimensions: Nominal load bank footprint shall be approximately 33 feet long by 16 feet wide. Actual dimensions of the final load bank provided shall be such that a clear space of no less than 6 feet is

provided around the perimeter of the load bank. Final load bank dimensions shall also allow for compliance with all workingspace requirements of NFPA 70.

b. Enclosure: NEMA 3R, or greater.

c. Voltage: 13.2kV

The load bank equipment and the connection between the load bank and the load bank connection cabinet shall be part of the "Load Bank" CLIN. The pad associated with the load bank and the load bank connection cabinet shall be part of the base bid CLIN identified on the plan set.

2.19 LOAD BANK CONNECTION CABINET

A permanent, pad mounted, air insulated, load bank connection cabinet shall be provided and installed. The load bank connection cabinet shall be rated no less than:

a. Voltage: 13.2kV

b. Current: The greater of 200A (minimum) or the rated continuous current output of the largest single generator unit.

c. Enclosure: NEMA 3R, or greater.

d. BIL: 95kV

e. Short Circuit Current Rating: As indicated.

f. Connectors: IEEE 386

2.20 VOLTAGE REGULATOR

Provide a solid-state voltage regulator, separate from the exciter, for each generator. Maintain the voltage within a bandwidth of the rated voltage, over a steady-state load range of zero to 100 percent of rated output capacity. Configure regulator for safe manual adjustment of the engine-generator voltage output without special tools, during operation, from 90 to 110 percent of the rated voltage over the steady state load range of 0 to 100 percent of rated output capacity. Regulation drift exceeding plus or minus 0.5 percent for an ambient temperature change of 68 degrees F is not acceptable. Reactive droop compensation or reactive differential compensation must load share the reactive load proportionally between sets during parallel operation. Provide voltage regulator with a maximum droop of 2 percent of rated voltage over a load range from 0 to 100 percent of rated output capacity and automatically maintain the generator output voltage within the specified operational bandwidth.

2.21 GENERATOR ISOLATION AND PROTECTION

2.21.1 Devices

Provide switches, circuit breakers, switchgear, fuses, relays, and other protective devices as specified in Section 26 13 13 METAL_CLAD SWITCHGEAR and 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

Furnish with respective pieces of equipment. Motors, controllers, contactors, and disconnects must conform to Section 26 20 00 INTERIOR

DISTRIBUTION SYSTEM. Provide electrical connections under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide controllers and contactors with maximum of 120-volt control circuits, and auxiliary contacts for use with controls furnished. When motors and equipment furnished are larger than size indicated, the cost of providing additional electrical service and related work must be included under this section.

2.22 SAFETY SYSTEM

Provide and install devices, wiring, remote panels, and local panels, etc., as a complete system to automatically activate the appropriate signals and initiate the appropriate actions. Provide a safety system with a self-test method to verify its operability. Provide alarm signals that have manual acknowledgment and reset devices. The alarm signal systems must reactivate for new signals after acknowledgment is given to any signal. Configure the systems so that loss of any monitoring device will be dealt with as an alarm on that system element.

2.22.1 Audible Signal

Provide audible alarm signal sound at a frequency of 70 Hz at a volume of 75 dB at 10 feet. The sound must be continuously activated upon alarm and silenced upon acknowledgment. Locate signal devices as shown.

2.22.2 Visual Signal

The visual alarm signal must be a panel light. The light must be normally off, activated to be blinking upon alarm. The light must change to continuously lit upon acknowledgement. If automatic shutdown occurs, the display must maintain activated status to indicate the cause of failure and must not be reset until cause of alarm has been cleared and/or restored to normal condition. Shutdown alarms must be red; all other alarms must be amber.

2.22.3 Alarms and Action Logic

2.22.3.1 Shutdown

Accomplish simultaneous activation of the audible signal, activation of the visual signal, stopping the engine, and opening the generator main circuit breakers.

2.22.3.2 Problem

Accomplish activation of the visual signal.

2.22.4 Safety Indications and Shutdowns

Provide a local alarm panel with the following shutdown and alarm functions in accordance with NFPA 110 level 1 mounted either on or adjacent to the engine generator set.

A remote alarm panel is required for audible alarms, e.g., in the control room.

Indicator Function (at battery voltage)	NFPA 99 Level 1 CV S RA	NFPA 110 Level 1 CV S RA	NFPA 110 Level 2 CV S RA
Overcrank	X X X	X X X	X X O
Low water temperature	X NA X	X NA X	X NA O
High engine temperature pre-alarm	X NA X	X NA X	O NA NA
High engine temperature	X X X	X X X	X X O
Low lube oil pressure pre-alarm	X NA X	NA NA NA	NA NA NA
Low lube oil pressure	X X X	X X X	X X O
Overspeed	X X X	X X X	X X O
Low fuel main tank	X NA X	X NA X	O NA O
Low coolant level	X O X	X O X	X O X
EPS supplying load	X NA NA	X NA NA	O NA NA
Control switch not in automatic position	X NA X	X NA X	X NA X
High battery voltage	X NA NA	X NA NA	O NA NA
Low cranking voltage	X NA X	X NA X	O NA NA
Low voltage in battery	X NA NA	X NA NA	O NA NA
Battery charger ac failure	X NA NA	X NA NA	O NA NA
Lamp test	X NA NA	X NA NA	X NA NA
Contacts for local and remote common alarm	X NA X	X NA X	X NA X
Audible alarm silencing switch	NA NA X	NA NA X	NA NA O
Low starting air pressure	X NA NA	X NA NA	O NA NA
Low starting hydraulic pressure	X NA NA	X NA NA	O NA NA
Air shutdown damper when used	X X X	X X X	X X O
Remote emergency stop	NA X NA	NA X NA	NA X NA

Indicator Function (at battery voltage)	NFPA 99 Level 1 CV S RA	NFPA 110 Level 1 CV S RA	NFPA 110 Level 2 CV S RA
Symbology: CV: Control panel-mounted visual. S: Shutdown of EPS indication. RA: Remote audible. Symbology: CV: Control panel-mounted visual. S: Shutdown of EPS indication. RA: Remote audible. X: Required. O: Optional. NA: Not applicable.			

2.22.5 Time-Delay on Alarms

For startup of the engine-generator set, install time-delay devices bypassing the low lubricating oil pressure alarm during cranking, and the coolant-fluid outlet temperature alarm. Submit the magnitude of monitored values which define alarm or action set points, and the tolerance (plus and/or minus) at which the devices activate the alarm or action for items contained within the alarm panels. The lube-oil time-delay device must return its alarm to normal status after the engine starts. The coolant time-delay device must return its alarm to normal status 5 minutes after the engine starts.

2.23 SYNCHRONIZING PANEL

Provide panel as specified in paragraph PANELS and provide controls, gauges, meters, and displays to include:

a. Frequency meters, dial type, with a range of 90 to 110 percent of rated frequency. Do not use vibrating-reed type meters . One must monitor generator output frequency ("Generator Frequency Meter") and the other must monitor the frequency of the parallel source ("Bus Frequency Meter").

b. Voltmeters, ac, dial type, 3-phase, with 4-position selector switch for the generator output ("Generator Volt Meter") and for the parallel power source ("Bus volt meter").

c. Automatic synchronizer.

d. Manual synchronizing controls.

e. Indicating lights for supplementary indication of synchronization.

f. Synchroscope.

g. Wattmeter, indicating.

2.24 SURGE PROTECTION

Electrical and electronic components must be protected from, or designed

to withstand the effects of surges from switching and lightning.

2.25 AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION

Provide fully automatic operation for the following operations: engine-generator set starting and load transfer upon loss of normal source; retransfer upon restoration of the normal source; sequential starting; paralleling, and load-sharing for multiple engine-generator sets; and stopping of each engine-generator set after cool-down. Devices must automatically reset after termination of their function.

2.25.1 Monitoring and Transfer

Provide devices to monitor voltage and frequency for the normal power source and each engine-generator set, and control transfer from the normal source and retransfer upon restoration of the normal source. Describe functions, actuation, and time delays as described in Section 26 36 23 AUTOMATIC TRANSFER SWITCH AND BY-PASS/ISOLATION SWITCH.

2.25.2 Automatic Paralleling and Loading of Engine-Generator Sets

Provide an automatic loading system to load and unload engine-generator sets in the sequence indicated. Monitor the system load and cause additional engine-generator sets to start, synchronize, and be connected in parallel with the system bus with increasing load. Actuation of the additional engine-generator set start logic must occur when the load exceeds a percentage set-point of the operating set's rating for a period of approximately 10 seconds. Provide an adjustable set-point range from 50 to 100 percent. When the system load falls below the percentage set-point of the operating set's rating for a period of approximately , the controller must unload and disconnect engine-generator sets from the system, stopping each engine-generator set after cool-down.

2.26 MANUAL ENGINE-GENERATOR-SET SYSTEM OPERATION

Provide complete facilities for manual starting and testing of each set without load, loading and unloading of each set, and synchronization of each set with an energized bus.

2.27 BASE

Provide a steel base. Design the base to rigidly support the engine-generator set, ensure permanent alignment of rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The base must permit skidding in any direction during installation and must withstand and mitigate the affects of synchronous vibration of the engine and generator. Provide base with suitable holes for anchor bolts and jacking screws for leveling.

2.28 THERMAL INSULATION

Provide thermal insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.29 PAINTING AND FINISHING

Clean, prime and paintthe engine-generator set in accordance with the manufacturer's standard color and practice.

2.30 FACTORY INSPECTION AND TESTS

Submit six complete reproducible copies of the factory inspection result on the checklist format specified below. Perform the factory tests on each engine-generator set. The component manufacturer's production line test is acceptable as noted. Run each engine-generator set for at least 1 hour at rated output capacity prior to inspections. Complete inspections and make all necessary repairs prior to testing. Use engine generator controls and protective devices that are provided by the generator set manufacturer as part of the standard package for factory tests. When controls and switchgear are not provided as part of the generator set manufacturer's standard package, the actual controls and protective devices provided for the project are not required to be used during the factory test. The Contracting Officer may provide one or more representatives to witness inspections and tests.

2.30.1 Factory Inspection

Perform inspections prior to beginning and after completion of testing of the assembled engine-generator set. Look for leaks, looseness, defects in components, proper assembly, etc. and note any item found to be in need of correction as a necessary repair. Use the following checklist for the inspection:

INSPECTION ITEM	GOOD	BAD	NOTES
Drive belts			
Governor and adjustments			
Engine timing mark			
Starting motor			
Starting aids			
Coolant type and concentration			
Radiator drains			
Block coolant drains			
Coolant fill level			
All coolant line connections			
All coolant hoses			
Combustion air filter			
Combustion air silencer			
Lube oil type			

INSPECTION ITEM	GOOD	BAD	NOTES
Lube oil sump drain			
Lube-oil filter			
Lube-oil-level indicator			
Lube-oil-fill level			
All lube-oil line connections			
All lube-oil lines			
Fuel type and amount			
All fuel-line connections			
All fuel lines			
Fuel filter			
Coupling and shaft alignment			
Voltage regulators			
Battery-charger connections			
All wiring connections			
Instrumentation			
Hazards to personnel			
Base			
Nameplates			
Paint			
Exhaust-heat recovery unit			
Switchboard			
Switchgear			

2.30.2 Factory Tests

Perform and report on factory tests and inspections prior to shipment. Provide certified copies of manufacturer's test data and results. Test procedures must conform to ASME, IEEE, IEC, and ANSI standards, and to ISO requirements on testing, as appropriate and applicable. The manufacturer performing the tests must provide equipment, labor, and consumables necessary for tests and measuring and indicating devices must be certified

to be within calibration. Tests must indicate satisfactory operation and attainment of specified performance. If satisfactory, equipment tested will be given a tentative approval. Equipment must not be shipped before approval of the factory test reports for the following tests.

All factory tests will be observed by the Enginer of Record. Submit a letter giving notice of the proposed dates of factory inspections and tests at least 60 days prior to beginning tests in order to schedule observing such tests, including:

a. A detailed description of the manufacturer's procedures for factory tests at least 14 days prior to beginning tests.

b. Six copies of the Factory Test data described below in 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Separate sections by heavy plastic dividers with tabs. Provide full size (8-1/2 by 11 inch minimum) data plots showing grid lines, with full resolution.

   (1) A detailed description of the procedures for factory tests.

   (2) A list of equipment used, with calibration certifications.

   (3) A copy of measurements taken, with required plots and graphs.

   (4) The date of testing.

   (5) A list of the parameters verified.

   (6) The condition specified for the parameter.

   (7) The test results, signed and dated.

   (8) A description of adjustments made.

On engine-generator set tests where the engine and generator are required to be connected and operated together, the load power factor must be the power factor specified in the engine generator set parameter schedule . Perform electrical measurements in accordance with IEEE 120. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulation must be in accordance with IEEE 1. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Tests specifically for the generator may be performed utilizing any prime mover.

a. Insulation Resistance for Stator and Exciter Test, IEEE 115 and IEEE 43, to the performance criteria in NEMA MG 1, Part 22. Generator manufacturer's production line test is acceptable.

b. High Potential Test, in accordance with IEEE 115 and NEMA MG 1, test voltage in accordance with NEMA MG 1. Generator manufacturer's production line test is acceptable.

c. Winding Resistance Test, Stator and Exciter, in accordance with IEEE 115. Generator manufacturer's production line test is acceptable.

d. Phase Balance Voltage Test, to the performance criteria specified in paragraph GENERATOR. This test can be performed with any prime mover. Generator manufacturer's production line test results are acceptable.

(1) Start and operate the generator at no load.

(2) Adjust a regulated phase voltage (line-to-neutral) to rated voltage.

(3) Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(4) Apply 75 percent rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(5) Apply rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(6) Calculate average line-neutral voltage and percent deviation of individual line-neutral voltages from average for each load condition.

e. Current Balance on Stator Winding Test, by measuring the current on each phase of the winding with the generator operating at 100 percent of Rated Output Capacity, with the load impedance equal for each of the three phases: to the performance criteria specified in paragraph GENERATOR.

f. Voltage Waveform Deviation and Distortion Test in accordance with IEEE 115 to the performance criteria specified in paragraph GENERATOR. Use high-speed recording instruments capable of recording voltage waveform deviation and all distortion, including harmonic distortion. Include appropriate scales to provide a means to measure and interpret results.

g. Voltage and Frequency Droop Test. Verify that the output voltage and frequency are within the specified parameters as follows:

(1) With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency. Record the generator output frequency and line-line and line-neutral voltages.

(2) Increase load to Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

(3) Calculate the percent droop for voltage and frequency with the following equations:

$$\text{Voltage droop percent} = \frac{\text{(No-Load Volts) - (Rated Capacity Volts)}}{\text{(Service-Load Volts)}} \times 100$$

$$\text{Frequency droop percent} = \frac{(\text{No-Load Hertz}) - (\text{Rated Capacity Hertz})}{(\text{Service-Load Hertz})} \times 100$$

(4) Repeat steps 1 through 3 two additional times without making any adjustments.

h. Frequency and Voltage Stability and Transient Response. Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Include the following tabular data:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Frequency (before and after load changes).

(5) Generator output power (before and after load changes).

(6) Graphic representations must include the actual instrument trace of voltage and frequency showing: charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

(a) Perform and record engine manufacturer's recommended pre-starting checks and inspections.

(b) Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

(c) With the unit at no load, apply the Maximum Step Load Increase.

(d) Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.

(e) Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.

(f) Apply the Maximum Step Load Increase.

(g) Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

(h) Repeat steps (c) through (g).

j. Test Voltage Unbalance with Unbalanced Load (Line-to-Neutral) to the performance criteria specified in paragraph GENERATOR. Prototype test data is acceptable in lieu of the actual test. Submit manufacturer's standard certification that prototype tests were performed for the generator model proposed. This test may be performed using any prime mover.

(1) Start and operate the generator set at rate voltage, no load, rated frequency, and under control of the voltage regulator. Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(2) Apply the specified load between terminals L_1-L_2, L_2-L_0, and L_3-L_0 in turn. Record all instrument readings at each line-neutral condition.

(3) Express the greatest difference between any two of the line-to-line voltages and any two of the line-to-neutral voltages as a percent of rated voltage.

(4) Compare the largest differences expressed in percent with the maximum allowable difference specified.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

Provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Submit a copy of the manufacturer's installation procedures and a detailed description of the manufacturer's recommended break-in procedure. Install pipe, duct, conduit, and ancillary equipment to facilitate easy removal and replacement of major components and parts of the engine-generator set. Comply with packaged engine-generator manufacturers' written installation, application, alignment instructions, and with NFPA 110.

3.2 PIPING INSTALLATION

Weld piping. Provide flanged valve connections. Provide flanged connections at equipment. Provide threaded connections to the engine if the manufacturers standard connection is threaded. Except where otherwise specified, use welded flanged fittings to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Make connections to equipment with vibration isolation-type flexible connectors. Support and align piping and tubing to prevent stressing of flexible hoses and connectors. Flash pipes extending through the roof. Install piping clear of windows, doors and openings, to permit thermal expansion and contraction without damage to joints or hangers, and install a 1/2 inch drain valve with cap at each low point.

The installation of gas engines must conform to the requirements of NFPA 37 and its references therein, including NFPA 54, NFPA 58, and ASME B31.3.

3.2.1 Support

Provide hangers, inserts, and supports to accommodate any insulation and conforming to MSS SP-58. Space supports no more than 7 feet on center for pipes 2 inches in diameter or less, no more than 12 feet on center for pipes larger than 2 inches but smaller than 4 inches in diameter, and not more than 17 feet on center for pipes larger than 4 inches in diameter. Provide supports at pipe bends or change of direction.

3.2.1.1 Ceiling and Roof

Support exhaust piping with appropriately sized Type 41 single pipe roll and threaded rods; support all other piping with appropriately sized Type 1 clevis and threaded rods.

3.2.1.2 Wall

Make wall supports for pipe by suspending the pipe from appropriately sized Type 33 brackets with the appropriate ceiling and roof pipe supports.

3.2.2 Flanged Joints

Provide flanges that are Class 125 type, drilled, and of the proper size and configuration to match the equipment and engine connections. Provide gasketed flanged joints that are square and tight.

3.2.3 Cleaning

After fabrication and before assembly, piping interiors must be manually wiped clean of debris.

3.2.4 Pipe Sleeves

Fit pipes passing through construction such as ceilings, floors, or walls with sleeves. Extend each sleeve through and fasten in its respective structure and cut flush with each surface. Build the structure tightly to the sleeve. The inside diameter of each sleeve must be minimum 1/2 inch, and where pipes pass through combustible materials 1 inch larger than the outside diameter of the passing pipe or pipe insulation/covering.

3.3 ELECTRICAL INSTALLATION

Perform electrical installation in compliance with NFPA 70, IEEE C2, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. For vibration isolation, provide flexible fittings for conduit, cable trays, and raceways attached to engine-generator sets; provide flexible stranded conductor for metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set; and provide crimp-type terminals or lugs for terminations of conductors on the engine generator set.

3.4 FIELD PAINTING

Perform field painting as specified in Section 09 90 00 PAINTS AND COATINGS.

3.5 ONSITE INSPECTION AND TESTS

Submit a letter giving notice of the proposed dates of onsite inspections

and tests at least 60 days prior to beginning tests.

a. Submit a detailed description of the Contractor's procedures for onsite tests including the test plan and a listing of equipment necessary to perform the tests at least 14 days prior to beginning tests.

b. Submit six copies of the onsite test data described below in 8-1/2 by 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Separate sections by heavy plastic dividers with tabs. Provide full size (8-1/2 by 11 inch minimum) data plots showing grid lines, with full resolution.

(1) A detailed description of the procedures for onsite tests.

(2) A list of equipment used, with calibration certifications.

(3) A copy of measurements taken, with required plots and graphs.

(4) The date of testing.

(5) A list of the parameters verified.

(6) The condition specified for the parameter.

(7) The test results, signed and dated.

(8) A description of adjustments made.

3.5.1 Test Conditions

3.5.1.1 Data

Make and record measurements of all parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, make adjustments, replacements, or repairs and repeat the step until satisfactory results are obtained. Unless otherwise indicated, record data in 15 minute intervals during engine-generator set operation and include: readings of all engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters and gauges supplied as permanent equipment on the engine-generator set. Perform electrical measurements in accordance with IEEE 120. Definitions of terms are in accordance with IEEE 100. Provide temperature limits in the rating of electrical equipment and for the evaluation of electrical insulations in accordance with IEEE 1.

3.5.1.2 Power Factor

Submit the generator capability curve showing generator kVA output capability (kW vs. kvar) for both leading and lagging power factors ranging from 0 to 1.0. For all engine-generator set operating tests the load power factor must be the power factor specified in the engine-generator set parameter schedule .

3.5.1.3 Contractor Supplied Items

Provide equipment and supplies required for inspections and tests

including fuel, test instruments, and loadbanks at the specified power factors.

3.5.1.4 Instruments

Verify readings of panel gauges, meters, displays, and instruments provided as permanent equipment during test runs, using test instruments of greater precision and accuracy. Test instrument accuracy must be within the following: current plus or minus 1.5 percent, voltage plus or minus 1.5 percent, real power plus or minus 1.5 percent, reactive power plus or minus 1.5 percent, power factor plus or minus 3 percent, frequency plus or minus 0.5 percent. Calibrate test instruments by a recognized standards laboratory within 30 days prior to testing.

3.5.1.5 Sequence

Provide the sequence of testing as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Perform field testing in the presence of the Contracting Officer. Schedule and sequence tests in order to optimize run-time periods; however, follow the general order of testing: Construction Tests; Inspections; Pre-operational Tests; Safety Run Tests; Performance Tests; and Final Inspection.

3.5.2 Construction Tests

Perform individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not provided by the engine-generator set manufacturer prior to connection to the engine-generator set.

3.5.2.1 Piping Test

a. Flush lube-oil and fuel-oil piping with the same type of fluid intended to flow through the piping, until the outflowing fluid has no obvious sediment or emulsion.

b. Test fuel piping which is external to the engine-generator set in accordance with NFPA 30. Pressure all remaining piping which is external to the engine-generator set with air pressure at 150 percent of the maximum anticipated working pressure, but not less than 150 psi, for a period of 2 hours to prove the piping has no leaks. If piping is to be insulated, perform the test before the insulation is applied.

3.5.2.2 Electrical Equipment Tests

a. Perform low-voltage cable insulation integrity tests for cables connecting the generatorto the distribution bus . Test low-voltage cable, complete with splices, for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. Apply a test voltage of 500 volts dc for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. Provide the minimum value of insulation as follows:

(1) R in meg-ohms = (rated voltage in kV plus 1) x 304.8/(length of cable in meters)

(2) R in meg-ohms = (rated voltage in kV plus 1) x 1000/(length of cable in feet)

(3) Each cable failing this test must be repaired or replaced. The repair cable must be retested until failures have been eliminated.

b. Perform medium-voltage cable insulation integrity tests for cables connecting the generator breaker to the generator switchgear . After installation and before the operating test or connection to an existing system, perform a high potential test on the medium-voltage cable system. Apply direct-current voltage on each phase conductor of the system by connecting conductors as one terminal and connecting grounds of metallic shields or sheaths of the cable as the other terminal for each test. Prior to making the test, isolate the cables by opening applicable protective devices and disconnecting equipment. Conduct the test with all splices, connectors, and terminations in place. Provide the method, voltage, length of time, and other characteristics of the test for initial installation in accordance with NEMA WC 74/ICEA S-93-639 for the particular type of cable installed, except provide 28kV and 35kV insulation test voltages in accordance with either AEIC CS8 or AEIC CS8 as applicable, and do not exceed the recommendations of IEEE 404 for cable joints and IEEE 48 for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, make necessary repairs or replace cables as directed. Retest repaired or replaced cables.

c. Neutral Ground-Resistance Tests. Measure the resistance of each neutral grounding resistor using the fall-of-potential method defined in IEEE 81 and testing procedure IEEE C57.32: O

HiPot Volt	19200
Rated Ohms	38.10
Ohms, -10%	34.19
Ohms, +10%	41.91

d. Examine and test circuit breakers and switchgear in accordance with the manufacturer's published instructions for functional testing.

3.5.3 Inspections

Perform the following inspections jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Submit a letter certifying that all facilities are complete and functional; that each system is fully functional; and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use. Perform checks applicable to the installation. Document and submit the results of those which are physical inspections (I) in accordance with paragraph SUBMITTALS. Present manufacturer's data for the inspections designated (D) at the time of inspection. Verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Provide manufacturer's

statements to certify provision of features which cannot be verified visually.

Drive belts	I
Governor type and features	I
Engine timing mark	I
Starting motor	I
Starting aids	I
Coolant type and concentration	D
Radiator drains	I
Block coolant drains	I
Coolant fill level	I
Coolant line connections	I
Coolant hoses	I
Combustion air filter	I
Intake air silencer	I
Lube oil type	D
Lube oil sump drain	I
Lube-oil filter	I
Lube-oil level indicator	I
Lube-oil fill level	I
Lube-oil line connections	I
Lube-oil lines	I
Fuel type	D
Fuel level	I
Fuel-line connections	I
Fuel lines	I
Fuel filter	I

Access for maintenance	I
Voltage regulator	I
Battery-charger connections	I
Wiring and terminations	I
Instrumentation	I
Hazards to personnel	I
Base	I
Nameplates	I
Paint	I
Exhaust-heat system	I
Exhaust muffler	I
Switchboard	I
Switchgear	I
Access provided to controls	I
Enclosure is weather resistant	I
Engine and generator mounting bolts (application)	I

3.5.4 Engine Tests

Perform customary commercial factory tests in accordance with ISO 3046 on each engine and associated engine protective device, including, but not limited to the following:

a. Perform dynamometer test at rated power. Record horsepower at rated speed and nominal characteristics such as lubricating oil pressure, jacket water temperature, and ambient temperature.

b. Test and record the values that the low oil pressure alarm and protective shutdown devices actuate prior to assembly on the engine.

c. Test and record values that the high jacket water temperature alarm and protective shutdown devices actuate prior to assembly on the engine.

3.5.5 Generator Tests

Tests must be performed on the complete factory assembled generator prior to shipment. Conduct tests in accordance with IEEE 115, IEC 60034-2A, and NEMA MG 1.

3.5.5.1 Routine Tests

Perform the following routine tests on the generators and their exciters:

a. Resistance of armature and field windings.

b. Mechanical balance.

c. Phases sequence.

d. Open circuit saturation curve and phase (voltage) balance test.

e. Insulation resistance of armature and field windings.

f. High potential test.

3.5.5.2 Design Tests

Submit the following design tests made on prototype machines that are physically and electrically identical to the generators specified.

a. Temperature rise test

b. Short circuit saturation curve and current balance test

3.5.6 Assembled Engine-Generator Set Tests

Perform the following tests on the assembled engine-generator set.

3.5.6.1 Initial Stabilization Readings

Operate the engine-generator set and allow the set to stabilize at rated kW at rated power factor, rated voltage, and rated frequency. During this period record instrument readings for output power (kW), terminal voltage, line current, power factor, frequency (rpm) generator (exciter) field voltage and current, lubricating oil pressure, jacket water temperature, and ambient temperature at minimum intervals of 15 minutes. Adjust the load, voltage, and frequency to maintain rated load at rated voltage and frequency. Adjustments to load, voltage, or frequency controls must be recorded on the data sheet at the time of adjustment. Stabilization must be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

3.5.6.2 Regulator Range Test

Remove load and record instrument readings (after transients have subsided). Adjust voltage to the maximum attainable value or to a value just prior to actuation of the overvoltage protection device. Apply rated load and adjust voltage to the minimum attainable value or a value just prior to activation of the under-voltage protection device. The data sheets must indicate the voltage regulation as a percent of rated voltage and the maximum and minimum voltages attainable. Voltage regulation must be defined as follows:

$$\text{Percent Regulation} = ((\text{No-Load Voltage}) - (\text{Rated-Load Voltage})) \times 100$$

(Rated-Load Voltage)

3.5.6.3 Frequency Range Test

Adjust the engine-generator set frequency for the maximum attainable frequency at rated load. Record instrument readings. Adjust the engine-generator set frequency for the specified minimum attainable frequency at rated load. Record instrument readings. Reduce the load to zero and adjust the engine-generator set frequency for the maximum attainable frequency. Record instrument readings. Adjust the engine-generator set frequency for the minimum attainable frequency. Record instrument readings. The data sheet must show the maximum and minimum frequencies attained at rated load, and at no load.

3.5.6.4 Transient Response Test

Drop the load to no load and re-apply rated load three times to ensure that the no load and rated load voltage and frequency values are repeatable and that the frequency and voltage regulation is within the limits specified. Record generator terminal voltage and frequency using a high speed strip chart recorder. The data sheet must show the following results:

a. Frequency

(1) Stability bandwidth or deviation in percent of rated frequency.

(2) Recovery time.

(3) Overshoot and undershoot.

b. Voltage

(1) Stability bandwidth or deviation in percent of rated voltage.

(2) Recovery time.

(3) Overshoot and undershoot.

3.5.7 Pre-operational Tests

3.5.7.1 Protective Relays

Visually and mechanically inspect, adjust, test, and calibrate protective relays in accordance with the manufacturer's published instructions. Include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Implement relay settings in accordance with the installation coordination study. Manually or electrically operate relay contacts to verify that the proper breakers and alarms initiate. Field test relaying current transformers in accordance with IEEE C57.13.1.

3.5.7.2 Insulation Test

Test generator and exciter circuits insulation resistance in accordance with IEEE 43. Take stator readings including generator leads to switchgear at the circuit breaker. Record results of insulation resistance tests. Readings must be within limits specified by the manufacturer. Verify

mechanical operation, insulation resistance, protective relay calibration and operation, and wiring continuity of switchgear assembly. Do not damage generator components during test.

3.5.7.3 Engine-Generator Connection Coupling Test

When the generator provided is a two-bearing machine, inspect and check the engine-generator connection coupling by dial indicator to prove that no misalignment has occurred. Use the dial indicator to measure variation in radial positioning and axial clearance between the coupling halves. Take readings at four points, spaced 90 degrees apart. Align solid couplings and pin-type flexible couplings within a total indicator reading of 0.0005 to 0.001 inch for both parallel and angular misalignment. For gear-type or grid-type couplings, 0.002 inch will be acceptable.

3.5.8 Safety Run Test

For the following tests, repeat the associated safety tests if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

c. Activate the manual emergency stop switch and verify that the engine stops.

d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine-generator set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If either temperature reading exceeds the value required for an alarm condition, activate the manual emergency stop switch.

f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a

reasonable warm-up period. Operate the engine generator-set at no load until the output voltage and frequency stabilize.

i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

k. Operate the engine generator-set for at least 2 hours at 75 percent of Service Load.

l. Verify proper operation and set-points of gauges and instruments.

m. Verify proper operation of ancillary equipment.

n. Manually adjust the governor to increase engine speed past the over-speed limit. Record the RPM at which the engine shuts down.

o. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.

p. Manually adjust the governor to increase engine speed to within 2 percent of the over-speed trip speed previously determined and operate at that point for 5 minutes. Manually adjust the governor to the rated frequency.

q. Manually fill the day tank to a level above the overfill limit. Record the level at which the overfill alarm sounds. Verify shutdown of the fuel transfer pump. Drain the day tank down below the overfill limit.

r. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine.

s. Attach a manifold to the engine oil system (at the oil pressure sensor port) that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. Move the engine's oil pressure sensor from the engine to the manifold. Open the manifold shutoff valve and close the bleed valve.

t. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75 percent of Service Load.

u. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.

v. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 100 percent of Service Load. Record the maximum sound level in each frequency band at a distance of 75 feet from the end of the exhaust and air intake piping directly along the path of intake and discharge for horizontal piping; or at a radius of 75 feet from the engine at 45 degrees apart in all directions for vertical piping. If a sound limiting enclosure is not provided, the muffler and air intake silencer as required to meet the sound limitations of this specification. If the sound limitations can not be obtained by modifying or replacing the muffler and air intake silencer, notify the Contracting Officers Representative and provide a recommendation for meeting the sound limitations.

w. Manually drain off fuel slowly from the day tank to empty it to below the low fuel level limit and record the level at which the audible alarm sounds. Add fuel back to the day tank to fill it above low level alarm limits.

3.5.9 Performance Tests

In the following tests, where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. For the following tests, repeat the associated tests if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries.

3.5.9.1 Continuous Engine Load Run Test

Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, repeat the entire test. Accomplish the engine load run test during daylight hours, with an average ambient temperature of 50 degrees F. After each change in load in the following test, measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the allowable range. Take data taken at 15 minute intervals and include the following:

Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.

Pressure: Lube-oil.

Temperature: Coolant, Lube-oil, Exhaust, Ambient.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.

c. Operate the engine generator-set for 2 hours at 75 percent of Service Load.

d. Increase load to 100 percent of Service Load and operate the engine generator-set for 4 hours.

e. For prime rated units, increase load to 110 percent of Service Load and operate the engine generator-set for 2 hours.

f. Decrease load to 100 percent of Service Load and operate the engine generator-set for 2 hours or until all temperatures have stabilized.

g. Remove load from the engine-generator set.

3.5.9.2 Voltage and Frequency Droop Test

For the following steps, verify that the output voltage and frequency return to and stabilize within the specified bandwidth values following each load change. Record the generator output frequency and line-line and line-neutral voltages following each load change.

a. With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency.

b. Increase load to 100 percent of Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

c. Calculate the percent droop for voltage and frequency with the following equations.

$$\text{Voltage droop percent} = \frac{\text{No-load volts - rated output capacity volts}}{\text{Rated output capacity volts}} \times 100$$

$$\text{Frequency droop percent} = \frac{\text{No load hertz - rated output capacity hertz}}{\text{Rated output capacity volts}} \times 100$$

d. Repeat steps a. through c. two additional times without making any adjustments.

3.5.9.3 Voltage Regulator Range Test

a. While operating at no load, verify that the voltage regulator adjusts from 90 to 110 percent of rated voltage.

b. Increase load to 100 percent of Rated Output Capacity. Verify that the voltage regulator adjusts from 90 to 110 percent of rated voltage.

3.5.9.4 Governor Adjustment Range Test

a. While operating at no load, verify that the governor adjusts from 90 to 110 percent of rated frequency.

b. Increase load to 100 percent of Rated Output Capacity. Verify that the governor adjusts from 90 to 110 percent of rated frequency.

3.5.9.5 Frequency and Voltage Stability and Transient Response

Verify that the engine-generator set responds to addition and dropping of

blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Include the following tabular data:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Frequency (before and after load changes).

(5) Generator output power (before and after load changes.

(6) Include the actual instrument trace of voltage and frequency in graphic representations showing:

Charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

c. With the unit at no load, apply the Maximum Step Load Increase.

d. Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.

e. Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100 percent of Service Load.

f. Apply the Maximum Step Load Increase.

g. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

h. Repeat steps c. through g.

3.5.10 Parallel Operation Test

Test the capability of each engine-generator set to parallel and share load with other generator sets, individually and in all combinations. This test must be performed with the voltage regulator and governor adjustment settings used for the Frequency and Voltage Stability and Transient Response test. If settings are changed during the performance

of this test, a voltage and frequency stability and transient response test must be performed for each engine generator set using the setting utilized in this test. During operations record load-sharing characteristics of each set in parallel operation. Include the following data:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Power division and exchange between generator sets.

(5) Real power (watts) and reactive power (vars) on each set.

3.5.10.1 Combinations

Connect each set, while operating at no load, parallel with one other set in the system, operating at service load, until all possible combinations have been achieved. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive loads. Document stabilization of voltage and frequency within specified bandwidth, the active power division, active power exchange, reactive power division, and voltage and frequency stability and transient response in the following steps for each combination.

a. Divide the load proportionally between the sets and operate in parallel for 15 minutes.

b. Increase the load, in steps equal to the Maximum Step Increase, until each set is loaded to its service load.

c. Decrease the load, in steps equal to the Maximum Step Decrease, until each set is loaded to approximately 25 percent of its service load.

d. Increase the load, in steps equal to the Maximum Step Increase, until each set is loaded to approximately 50 percent of its service load Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive load.

e. Reduce the sum of the loads on both sets to the output rating of the smaller set.

f. Transfer a load equal to the output rating of the smaller of the 2 sets to and from each set. Verify stabilization of voltage and frequency within specified bandwidths and proportional sharing of real and reactive load.

g. Document the active power division, active power exchange, reactive power division, and voltage and frequency stability and transient response.

3.5.10.2 Multiple Combinations

Connect each set, while operating at no load, parallel with all multiple combinations of all other set in the system, while operating at service load, until all multiple combinations of parallel operations have been achieved.

3.5.11 Parallel Operation Test (Commercial Source)

Connect each set parallel with the commercial power source. Operate in parallel for 15 minutes. Verify stabilization of voltage and frequency within specified bandwidths. Record the output voltage, frequency, and loading to demonstrate ability to synchronize with the commercial power source.

3.5.12 Automatic Operation Tests

Test the automatic operating system to demonstrate automatic starting, loading and unloading, the response to loss of operating engine-generator sets, and paralleling of each engine-generator set. Utilize load banks at the indicated power factor and actual loads to be served for this test, and the loading sequence is the indicated sequence. Record load-sharing characteristics during all operations. Perform this test for a minimum of two successive, successful tests. Include the following data:

(1) Ambient temperature (at 15 minute intervals).

(2) Generator output current (before and after load changes).

(3) Generator output voltage (before and after load changes).

(4) Generator output frequency (before and after load changes).

(5) Power division and exchange between generator sets.

(6) Real and reactive power on each set.

a. Initiate loss of the preferred power source and verify the specified sequence of operation.

b. Verify resetting of automatic starting and transfer logic.

3.6 GROUNDING

NFPA 70 and IEEE C2, except that grounding systems must have a resistance to solid earth ground not exceeding 5 ohms.

3.6.1 Engine-Generator Set Grounding

Provide separate copper grounding conductors and connect them to the ground system as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" must apply.

3.6.2 Connections

Make joints in grounding conductors by exothermic weld or compression connector. Exothermic welds and compression connectors must be installed as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION paragraph regarding GROUNDING.

3.6.3 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.7 START-UP ENGINEER

Provide the services of a qualified factory trained start-up engineer, regularly employed by the engine-generator set manufacturer. The start-up services must include conducting preliminary operations and functional acceptance tests. The start-up engineer must be present at the engine generator set installation-site, full-time, while preliminary operations and functional acceptance tests are being conducted.

3.8 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING

Completion of the following requirements is mandatory prior to scheduling functional acceptance tests for the engine-generator set and auxiliary equipment.

3.8.1 Piping Tests

Complete as specified in 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT)

3.8.2 Performance of Acceptance Checks and Tests

The acceptance checks and tests must be accomplished by the testing organization as described in Section 26 08 00 APPARATUS INSPECTION AND TESTING.

3.8.3 Generator Sets

Complete as specified in the paragraph ACCEPTANCE CHECKS AND TESTS.

3.8.3.1 Automatic Transfer Switches

Complete acceptance checks and tests as specified in Section 26 36 23 AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH.

3.8.4 Preliminary Operations

The start-up engineer must conduct manufacturer recommended start-up procedures and tests to verify that the engine-generator set and auxiliary equipment are ready for functional acceptance tests. Give the Contracting Officer 15 days' advance notice that preliminary operations will be conducted. After preliminary operation has been successfully conducted, the start-up engineer will notify the Contracting Officer in writing stating the engine-generator set and auxiliary equipment are ready for functional acceptance tests.

3.8.5 Preliminary Assembled Operation and Maintenance Manuals

Preliminary assembled operation and maintenance manuals must have been submitted to and approved by the Contracting Officer. Manuals must be prepared as specified in the paragraph ASSEMBLED OPERATION AND MAINTENANCE MANUALS.

3.8.6 Functional Acceptance Test Procedure

Test procedure must be prepared by the start-up engineer specifically for the engine-generator set and auxiliary equipment. The test agenda must cover the requirements specified in the paragraph FUNCTIONAL ACCEPTANCE TESTS. The test procedure must indicate in detail how tests are to be conducted. A statement of the tests that are to be performed without

indicating how the tests are to be performed is not acceptable. Indicate what work is planned on each workday and identify the calendar dates of the planned workdays. Specify what additional technical support personnel is needed such as factory representatives for major equipment. Specify on which testing workday each technical support personnel is needed. Data recording forms to be used to document test results are to be submitted with the proposed test procedure. A list of test equipment and instruments must also be included in the test procedure.

3.8.7 Test Equipment

Test equipment and instruments must be on hand prior to scheduling field tests or, subject to Contracting Officer approval, evidence must be provided to show that arrangements have been made to have the necessary equipment and instruments on-site prior to field testing.

3.9 FIELD QUALITY CONTROL

Give Contracting Officer 30 days' notice of dates and times scheduled for tests which require the presence of the Contracting Officer. The Contracting Officer will coordinate with the using activity and schedule a time that will eliminate or minimize interruptions and interference with the activity operations. The Contractor must be responsible for costs associated with conducting tests outside of normal working hours and with incorporating special arrangements and procedures, including temporary power conditions. The Contractor must provide labor, equipment, fuel, test load, and consumables required for the specified tests. The test load must be a cataloged product. Calibration of measuring devices and indicating devices must be certified. Refer to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, for requirements for a cataloged product. Perform the following field tests.

3.9.1 Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.9.1.1 Circuit Breakers - Low Voltage Insulated Case/Molded Case

a. Visual and Mechanical Inspection

(1) Compare nameplate data with specifications and approved shop drawings.

(2) Inspect circuit breaker for correct mounting.

(3) Operate circuit breaker to ensure smooth operation.

(4) Inspect case for cracks or other defects.

(5) Verify tightness of accessible bolted connections and cable connections by calibrated torque-wrench method. Thermo-graphic survey is not required.

(6) Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

(1) Perform contact-resistance tests.

(2) Perform insulation-resistance tests.

(3) Adjust breaker(s) for final settings in accordance with engine-generator set manufacturer's requirements.

3.9.1.2 Current Transformers

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify correct connection.

(4) Verify that adequate clearances exist between primary and secondary circuit.

(5) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermo-graphic survey is not required.

(6) Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

(1) Perform insulation-resistance tests.

(2) Perform polarity tests.

(3) Perform ratio-verification tests.

3.9.1.3 Metering and Instrumentation

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of electrical connections.

b. Electrical Tests

(1) Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

(2) Calibrate watt-hour meters according to manufacturer's published data.

(3) Verify all instrument multipliers.

(4) Electrically confirm that current transformer secondary circuits are intact.

3.9.1.4 Battery Systems

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermo-graphic survey is not required.

(4) Measure electrolyte specific gravity and temperature and visually check fill level.

(5) Verify adequacy of battery support racks, mounting, anchorage, and clearances.

b. Electrical Tests

(1) Set charger float and equalizing voltage levels.

(2) Verify all charger functions and alarms.

(3) Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.

(4) Perform a capacity load test.

3.9.1.5 Engine-Generator Set

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Inspect for correct anchorage and grounding.

b. Electrical and Mechanical Tests

(1) Perform an insulation-resistance test on generator winding with respect to ground. Calculate polarization index.

(2) Perform phase rotation test to determine compatibility with load requirements.

3.9.1.6 Grounding System

a. Visual and Mechanical Inspection

(1) Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

(1) Perform ground-impedance measurements utilizing the fall-of-potential method defined in IEEE 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. Take measurements in normally dry weather, not less than 48 hours after rainfall. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance.

3.9.2 Functional Acceptance Tests

The tests must be performed by the start-up engineer and verify Sequence Of Operations provided within Section 26 13 13 METAL CLAD SWITCHGEAR . Upon successful test completion, the start-up engineer must provide the Contracting Officer with a written test report within 15 calendar days showing the tests performed and the results of each test. The report must include the completed approved test data forms and certification from the start-up engineer that the test results fall within the manufacturer's recommended limits and meet the specified requirements performance. The report must be dated and signed by the start-up engineer, and submitted for approval by the Contracting Officer. The Contracting Officer will witness final acceptance tests. Testing must include, but not be limited to, the following:

a. Verify proper functioning of each engine protective shutdown device and pre-shutdown alarm device. Testing of the devices must be accomplished by simulating device actuation and observing proper alarm and engine shutdown operation.

b. Verify proper functioning of the engine over-speed trip device. Testing of the over-speed trip device must be accomplished by raising the speed of the engine-generator set until an over-speed trip is experienced.

c. Verify proper functioning of the crank cycle/terminate relay. Testing of the relay must be accomplished by engaging the starter motor with the engine being prevented from running. Observe the complete crank/rest cycle as described in the paragraph STARTING SYSTEM.

d. Verify proper functioning of the following automatic and manual operations. Testing must include, but not be limited to, the following:

(1) Loss of Utility: Initiate a normal power failure with connected test load of rated kW at 1.0 power factor. Record time delay on start, cranking time until engine starts and runs, time to come up to operating speed, voltage and frequency overshoot, and time to achieve steady state conditions with all switches transferred to emergency position.

(2) Return of Utility: Return normal power and record time delay on retransfer for each automatic transfer switch, and time delay on engine cool-down and shutdown.

(3) Manual starting.

(4) Emergency stop.

e. Operate the engine-generator sets at rated current (amperes) until the jacket water temperature stabilizes. Stabilization will be considered

to have occurred when three consecutive temperature readings remain unchanged. Continue to operate the generator set for an additional 2 hours. Record instrument readings for terminal voltage, line current, frequency (Hz), engine speed rpm, lubricating oil pressure, jacket water temperature, and ambient temperature at 5 minute intervals for first 15 minutes and at 15 minute intervals thereafter.

f. Emissions Tests. Provide on-site testing by a certified testing organization of each engine-generator set. Testing must be in accordance with an EPA approved method, 40 CFR 60, (Appendix, Method 7, 7A, 7B, 7C, 7D or 7E). Emissions at rated full load must be within the limits specified in the paragraph ENGINE EMISSIONS LIMITS.

g. Exhaust System Manufacturer's Testing. Manufacturer shall demonstrate, utilizing portable emission measuring equipment, that engine-out and SCR-out emissions are within to meet the parameters to meet the EPA Tier 4 requirements. At a minimum measure and record at 100% load, for 1 hour run duration, the following items:

(1) Engine-out NOx, CO, O2.

(2) Post-SCR catalyst NOx, CO, O2.

(3) Differential pressure across the total emission control system.

(4) Exhaust temperature catalyst housing inlet.

(5) Exhaust temperature at catalyst housing outlet.

(6) Urea flow rate.

(7) Urea dosing valve position.

3.10 DEMONSTRATION

Upon completion of the work and at a time approved by the Contracting Officer, the Contractor must provide instructions by a qualified instructor to the Government personnel in the proper operation and maintenance of the equipment. Twelve Government personnel must receive training comparable to the equipment manufacturer's factory training. The duration of instruction must be for not less than one 8 hour working day for instruction of operating personnel and not less than one 8 hour working day for instruction of maintenance personnel.

3.10.1 Instructor's Qualification Resume

Instructors must be regular employees of the engine-generator set manufacturer. The instruction personnel provided to satisfy the requirements above must be factory certified by the related equipment manufacturer to provide instruction services. Submit the name and qualification resume of instructor to the Contracting Officer for approval.

3.10.2 Training Plan

Submit training plan 30 calendar days prior to training sessions. Training plan must include scheduling, content, outline, and training material (handouts). Content must include, but not be limited to, the following:

3.10.2.1 Operating Personnel Training

This instruction includes operating the engine-generator set, auxiliary equipment including automatic transfer switches in all modes, and the use of all functions and features specified.

3.10.2.2 Maintenance Personnel Training

Training must include mechanical, hydraulic, electrical, and electronic instructions for the engine-generator set and auxiliary equipment including automatic transfer switches.

a. Mechanical Training: Must include at least the following:

(1) A review of mechanical diagrams and drawings.

(2) Component location and functions.

(3) Troubleshooting procedures and techniques.

(4) Repair procedures.

(5) Assembly/disassembly procedures.

(6) Adjustments (how, when, and where).

(7) Preventive maintenance procedures.

(8) Review of flow diagram.

(9) Valve locations and function.

(10) Valve and hydraulic equipment adjustment and maintenance procedures.

(11) Hydraulic system maintenance and servicing.

(12) Lubrication points, type, and recommended procedures and frequency.

b. Electrical and Electronic Maintenance Training: Must include at least the following:

(1) A review of electrical and electronic systems including wiring diagrams and drawings.

(2) Troubleshooting procedures for the machine and control systems.

(3) Electrical and electronic equipment servicing and care.

(4) Use of diagnostics to locate the causes of malfunction.

(5) Procedures for adjustments (locating components, adjustments to be made, values to be measured, and equipment required for making adjustments).

(6) Maintenance and troubleshooting procedures for microprocessor or minicomputer where applicable.

(7) Circuit board repair procedures where applicable (with schematics provided).

(8) Use of diagnostic tapes.

(9) Recommended maintenance servicing and repair for motors, switches, relays, solenoids, and other auxiliary equipment and devices.

3.11 ONSITE TRAINING

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period must consist of a total 4 hours of normal working time and must start after the system is functionally completed but prior to final acceptance.

a. Submit a letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the digital video recording to be provided. The course instructions must cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as major elements of the operation and maintenance manuals. Additionally, the course instructions must demonstrate routine maintenance procedures as described in the operation and maintenance manuals.

b. Submit a digital video recording of the entire training session .

c. One full size reproducible Mylar ach drawing must accompany the booklets. Mylars must be rolled and placed in a heavy cardboard tube with threaded caps on each end. The manual must include step-by-step procedures for system startup, operation, and shutdown; drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems together with their controls, alarms, and safety systems; the manufacturer's name, model number, and a description of equipment in the system. The instructions must include procedures for interface and interaction with related systems to include fire alarm/suppression systems load shedding systems . Each booklet must include a CD containing an ASCII file of the procedures.

d. Provide approved operation and maintenance manuals for the training course. Post approved instructions prior to the beginning date of the training course. Coordinate the training course schedule with the using service's work schedule, and submit for approval 14 days prior to beginning date of proposed beginning date of training.

3.12 POSTED DATA AND INSTRUCTIONS

Post Data and Instructions prior to field acceptance testing of the engine generator set. Provide two sets of instructions/data, typed and framed under weatherproof laminated plastic, and post side-by-side where directed. Include a one-line diagram, wiring and control diagrams and a complete layout of the system in the first set. Include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions in the second set. Submit posted data including wiring and control diagrams showing the key mechanical and electrical control elements, and a complete

layout of the entire system.

a. Include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches).

b. Submit instructions including: the manufacturers pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches). Provide weatherproof instructions, laminated in plastic, and post where directed.

3.13 ACCEPTANCE

Submit drawings which accurately depict the as-built configuration of the installation, upon acceptance of the engine-generator set installation. Revise layout drawings to reflect the as-built conditions and submit them with the as-built drawings. Final acceptance of the engine-generator set will not be given until the Contractor has successfully completed all tests and all defects in installation material or operation have been corrected.

-- End of Section --

SSR# 20231115a

Jan 05, 2024

To Whom It May Concern:

With regards to Cummins manufactured diesel generator set model DQLE rated for 60 Hz operation at 13200 volts, equipped with Cummins QSK78-G12 engine, Stamford alternator model S9H1D-F4 Wdg.991 with 105°C/40°C temperature rise class and Cummins set-mounted high ambient cooling system:

When applied at the site of:

Buckley Space Force Base
Space Force CEB
Buckley Space Force Base,
Aurora, CO 80011
US

With ambient design conditions of 38.8°C (102°F) as measured at the equipment room inlet and inclusive of engine and alternator heat rejection to the equipment room, with a maximum external cooling system restriction of 0.125 kPa (0.5 inches of water), and 1693 meters (5555 feet) above mean sea level, the generator set is capable of operating at a Data Center Continuous (DCC) rating of 1600 kWe / 2000 kVA for unlimited hours when installed per Cummins application guidelines, as per the requirements of the Uptime Institute.

Maintenance intervals, including time to overhaul, will be directly correlated to the actual run hours and load levels to which the generator set is applied. Therefore, maintenance intervals should be aligned with the actual use of the generator set as described in the Operator's and Service manuals. This letter does not supersede any of the commercial terms of sale, including, but not limited to, warranty coverage.

Cummins approves this rating; however, if ever these generator sets are operated in a different application, the power distribution system is modified or there is any other change to the site design conditions, Cummins must be notified and further actions may need to be taken.

For further questions on this product or application, please contact the local Cummins distributor.

Best Regards,

Ashish R Gupta
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980-226-7079
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SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH

05/20, CHG 1: 08/21

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SECTION 26 36 23

AUTOMATIC TRANSFER SWITCHES AND BY-PASS/ISOLATION SWITCH
05/20, CHG 1: 08/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 110	(2022) Standard for Emergency and Standby Power Systems

UL SOLUTIONS (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 1008	(2022) UL Standard for Safety Transfer Switch Equipment

UL 1066	(2022) UL Standard for Safety Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Automatic Transfer Switch Drawings; G, DO

SD-03 Product Data

Automatic Transfer Switches; G, DO

By-Pass/Isolation Switch (BP/IS); G, DO

SD-06 Test Reports

Acceptance Checks and Tests; G, RO

Functional Acceptance Tests; G, RO

Factory Testing; G, RO

Factory Test Reports; G, RO

SD-07 Certificates

Proof of Listing; G, RO

SD-10 Operation and Maintenance Data

Operation and Maintenance Manual, Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, Data Package 5; G, RO

1.2.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.3 OPERATION AND MAINTENANCE MANUAL

Assemble and bind manuals in durable, hard-covered, water resistant binders. Assemble and index the manuals per the following table of contents:

a. Manufacturer's O&M per "SD-10 Operation and Maintenance Data".

b. Catalog data required by "SD-03 Product Data"

c. Drawings required by "SD-02 Shop Drawings".

1.3.1 Additions to Operation and Maintenance Manuals

In addition to requirements of SD-10 Data Package 5, include the followings on the actual equipment provided:

a. An outline drawing, front, top, and side views.

b. Prices for spare parts and supply list.

c. Date of Purchase.

d. Corrective maintenance procedures.

e. Operating manual outlining step-by-step procedures for system startup, operation, and shutdown.

f. Include simplified wiring and control diagrams in the manual for system as installed.

g. Provide typical contact voltage drop readings under specified conditions for use during periodic maintenance. Provide instructions for determination of contact integrity.

1.3.2 Spare Parts

Furnish the following the following minimum spare parts and any other spare parts required in one-year operation, of the same material and workmanship, meeting the same requirements, and interchangeable with the corresponding original parts.

a. Fuses: Two of each type and rating.

1.4 QUALITY ASSURANCE

1.4.1 Proof of Listing

Submit proof of listing by UL 1008.

1.4.2 Automatic Transfer Switch Drawings

Include the following as a minimum:

a. An outline drawing, including front, top, and side views.

b. Provide a nameplate of corrosion-resistant material with not less than 1/8 inch tall characters showing manufacturer's name and equipment ratings. Mount nameplate to front of enclosure and meet the nameplate requirements of NEMA ICS 2.

c. Provide detail drawings that include manufacturer's name and catalog number, electrical ratings, total system transfer statement, reduced normal supply voltage at which transfer to the alternate supply is initiated, transfer delay times, short-circuit current rating, wiring diagram, description of interconnections, testing instructions, acceptable conductor type for terminals, tightening torque for each wire connector, and other required UL 1008 markings.

d. Submit interface equipment connection diagram showing conduit and wiring between ATS and related equipment. Provide diagrams showing interlocking provisions and cautionary notes, if any.

e. Drawings are to indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.4.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated

1.4.4 Standard Product

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.

b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.4.1 Alternative Qualifications

Products having less than a 2-year field service record are acceptable if the manufacturer has been regularly engaged in the design and production of automatic transfer switches and if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 years prior to date of delivery to site are not acceptable.

1.5 DELIVERY AND STORAGE

Protect equipment placed in storage from humidity and temperature variations, moisture, water intrusion, dirt, dust, or other contaminants. In harsh environments where temperatures exceed non-operational parameters established within this specification, provide an environmentally controlled equipment storage facility to ensure temperature parameters are within equipment specification. Provide documentation of same to the Government when storage is implemented.

1.6 ENVIRONMENTAL CONDITIONS

Provide an ATS that is suitable for prolonged performance under following service conditions:

a. Operating altitude: Sea level to 3,300 ft. (Systems applied at higher altitudes are to be derated in accordance with the manufacturer's instructions).

b. Operating ambient temperature range: 40 to 104 degrees F.

c. Operating relative humidity: 0 to 90 percent, without condensation.

1.7 SEISMIC REQUIREMENTS

Provide seismic details conforming to Section 26 05 48, SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCHES

Each automatic transfer switch must be rated and marked for total system transfer and have the current and voltage ratings as indicated. Provide a switch operating mechanism that is electrically operated, have quick-make, quick-break, load break contacts, and be mechanically held in both positions. Switches utilizing circuit breakers are not acceptable. Provide an ATS that is UL listed. ATS must be manufactured and tested in accordance with applicable requirements of NEMA ICS 2, UL 1008 and UL 1066. ATS must conform to NFPA 110. Provide the ATS with the following characteristics:

a. Voltage: 480 volts ac.

b. Amperage: As Indicated on EP601. Provide an ATS with a continuous load current rating of the switch rating.

c. Number of Phases: Three.

d. Number of Wires: Four.

e. Frequency: 60 Hz.

f. Poles: Four switched. One of the poles is the neutral.

g. ATS Withstand Current Rating: ATS must be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals. The ATS must be listed in accordance with UL 1008 for 18 cycle close and withstand ratings.

h. Nonwelding Contacts: Provide contacts that are nonwelding at the available fault current rating. Contacts must be suitable for repetitive power transfer switching. Switches rated 800 amps and above must have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

i. Phase and Neutral Contacts: Provide contacts with silver alloy composition. Provide neutral contacts with the same continuous

current rating as main or phase contacts.

j. Configuration. Provide an ATS for use in emergency systems described in NFPA 70. Provide an ATS that is listed for emergency use.

k. ATS Configuration. Provide an open transition ATS.

2.1.1 Undervoltage Sensing - Normal/Preferred Source

Undervoltage Sensing - Normal Source. Provide undervoltage sensing for each phase in the normal/preferred source. Sense low phase-to-ground voltage on each phase. Provide sensing circuit with adjustable dropout, 75-98 percent of nominal value and adjustable pickup, 85-100 percent of nominal value. Factory set dropout value to 90percent. Factory set pickup value to 90percent.

2.1.2 Voltage/Frequency Lockout Relay - Alternate/Emergency Source

Voltage/Frequency Lockout Relay. Three-phase sensing must be provided on the normal and emergency source. Prevent premature transfer to alternate/emergency source. Provide pickup voltage that is adjustable from 85-100 percent of nominal. Factory set for pickup at 90 percent. Provide pickup frequency that is adjustable from 90-97 percent of nominal. Factor set frequency pickup for 95 percent.

2.1.3 Adjustable Time Delay - Transfer to Alternate/Emergency Power Source

Adjustable Time Delay - Transfer to Alternate Power Source. Transfer to alternate power source time delay for transfer switches as indicated, adjustable 0-5 minutes. Factory set to 10 seconds. ATS is to monitor the frequency and voltage of alternate power source and transfer when frequency and voltage are stabilized.

2.1.4 Adjustable Time Delay- Re-transfer to Normal/Preferred Source

Adjustable Time Delay- Transfer to Source. Re-transfer to normal source time delay, adjustable 0-30 minutes. Factory set at 10 minutes. Time delay is automatically defeated upon loss or sustained undervoltage of alternate power source, provided that normal source has been restored.

2.1.5 Engine-Generator Exerciser

Exerciser. Solid-state, programmable-time switch exerciser to allow automatic starting of the generator set, subsequent load transfer, retransfer of load and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from on a daily, weekly, bi-weekly or monthly basis.. Running periods are adjustable from 10-30 minutes. Factory settings are for 7-day exercise cycle, 20 minute running period and 5-minute cool-down period. Exerciser features include the following:

a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer or dual independent exercisers that allow for unloaded and loaded schedule testing.

b. Push-button programming control with digital display of settings.

c. Integral battery operation of time switch when normal control power is not available.

2.1.6 Unassigned Auxiliary Contacts

Provide two normally open and two normally closed, single-pole, double-throw auxiliary contacts for each switch position rated at 10 amperes at 480 volts.

2.1.7 Front Panel Devices

Provide devices mounted on cabinet front consisting of:

a. Mode selector switch with the following positions and associated functions. Selector switch can be part of the microprocessor controller consisting of an LCD screen with a graphical interface or as a stand-alone test switch.

(1) TEST - Simulates loss of normal/preferred source system operation.

(2) NORMAL - Transfers system to normal/preferred source bypassing re-transfer time delay.

b. Switch position indicating lights or graphical LCD display. Indicate source to which load is connected.

c. Source-Available Monitor. Provide source-available indicating lights or graphical LCD display monitor that is labeled to show when one or both sources of power are available. If indicating lights are used, then the preference is to have Green be normal/preferred power and Red be for alternate/emergency power; however, other color schemes are allowed if clearly marked.

d. Lamp test button.

2.1.8 In-Phase Monitor

Provide an in-phase monitor that consists of a factory-wired, internal relay that controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 5 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage Manufacturer is to provide information regarding what conditions a transfer cannot be accomplished.

2.2 BY-PASS/ISOLATION SWITCH (BP/IS)

Include non-load-break by-pass/isolation switches for the indicated automatic transfer switches. Designs which disconnect or interrupt the load when bypassing are not acceptable. Include the following features for each combined by-pass/isolation switch and automatic transfer switch:

a. Bypass/isolation switch (BP/IS) and associated ATS are to be made by the same manufacturer and must be completely interconnected and tested at factory and at project site as specified.

b. ATS is to be manufactured, listed and tested in accordance with paragraph AUTOMATIC TRANSFER SWITCH. BP/IS switch current, voltage, closing, and short-circuit withstand closing ratings are to be equal

or exceed comparable ratings specified for ATS and have the same phase arrangement and number of poles.

c. Provide externally operated and arranged selector switch or handle so designed and constructed not to stop in an intermediate or neutral position during operation and that one person can safely bypass the ATS. Accomplish isolation of the ATS externally by one person. Bypass and isolation handles must be permanently affixed and operable without opening the enclosure door. Provide interlocks that ensure ATS is disconnected from source and load during isolation. Interlocks prevent ATS operation, except for testing and maintenance, while isolated. BP/IS operation is to be accomplished without disconnecting switch load terminal conductors. Equipment which require separate tools, keys, or other devices to operate the bypass/isolation mechanism which may not be present during an emergency is not acceptable.

d. Provide drawout transfer switch that provides physical separation from bypass switch and live parts and accessibility for testing and maintenance operation.

e. Provide contacts that have the same contact temperature that do not exceed those of the ATS contacts when carrying rated load. Provide contacts as specified for associated ATS, including provisions for inspection of contacts without disassembly of BP/IS or removal of entire contact enclosure. Provide manufacturer instructions for determining contact integrity in order To facilitate maintenance.

f. The ATS controls remain functional with the ATS isolated or in bypass mode to permit monitoring of the normal power source and automatic starting of the generator in the event of a loss of the normal power source. In the isolated mode, the bypass section is capable of functioning as a manual transfer to transfer the load to either power source for maintenane purposes or when automatic control has failed. Equipment that requires automatic controls to be functional to operate the bypass switch is not acceptable.. The ATS can be completely removed from the enclosure, if required for maintenance or repair, while the bypass section continues to power the load.

h. Construct Bypass/isolation switch for convenient removal of parts from front of switch enclosure without removal of other parts or disconnection of external power conductors.

i. Achieve load by-pass to the source with no load interruption. Bypass/isolation equipment that breaks the load is not accpetalbe.

k. Provide a means to ensure the switch is transferred to the alternate or emergency power source when normal power source becomes unavailable.

2.2.1 Markings

Mark isolation handle positions with engraved plates or other approved means to indicate position or operating condition of associated ATS, as follows:

a. Provide an indication that shows that BP/IS section is providing power to the load.

b. Provide indication of ATS isolation/test position.

c. Provide suitable control labels and instruction signs describing operating instructions.

d. Indicating lamps or LCD screen for indicating that shows the source availability, bypass switch position, transfer switch position, and isolation handle position. If indicating lights are used, provide a lamp test button that turns the indicating lights on, but does not cause any function to take place.

2.2.2 Interconnection

Interconnect BP/IS and associated ATS with suitably sized copper bus bars silver-plated at each connection point, and braced to withstand magnetic and thermal forces created at withstand current rating specified for associated ATS.

2.3 ENCLOSURE

Provide an enclosure that meets the following:

a. Provide ATS and accessories in a wall-mounted, ventilated NEMA 250, Type 1, smooth sheet metal enclosure constructed in accordance with applicable requirements of NEMA ICS 6, UL 508, UL 1066, and UL 1008. Provide door with suitable hinges, locking handle latch, and gasketed jamb. Provide at least No. 14 metal gauge.

b. Factory wiring within enclosure and field wiring terminating within enclosure must comply with NFPA 70. Provide wire that is permanently tagged or marked near terminal at each end with wire number shown on approved detail drawing, when wiring is not color coded. Conform terminal block to NEMA ICS 4. Arrange terminals for entrance of external conductors from top and bottom of enclosure as shown. Main switch terminals, including neutral terminal if used, must be pressure type suitable for termination of external copper conductors shown.

2.3.1 Construction

Construct enclosure for ease of removal and replacement of ATS components and control devices from front without disconnection of external power conductors or removal or disassembly of major components.

2.3.2 Cleaning and Painting

Protect both the inside and outside surfaces of an enclosure, including means for fastening against corrosion by enameling, galvanizing, plating, powder coating, or other equivalent means. Protection is not required for metal parts that are inherently resistant to corrosion, bearings, sliding surfaces of hinges, or other parts where such protection is impractical. Provide manufacturer's standard finish material, process, and color that is free from runs, sags, peeling, or other defects. An enclosure marked Type 1, 3R, 4 or 12 is acceptable if there is no visible rust at the conclusion of a salt spray (fog) test using the test method in ASTM B117, employing a 5 percent by weight, salt solution for 24 hours. Type 4X enclosures are acceptable following performance of the above test with an exposure time of 200 hours.

2.3.3 Field Fabricated Nameplates

Nameplate is to comply with ASTM D709. Provide laminated plastic nameplates for each equipment enclosure as specified or as indicated on the drawings. Provide an inscription on each nameplate that identifies the name of the equipment, sources of power, calculated short circuit with date and the location e.g. 'SWB-1 Electrical Room 103'. Provide nameplates that are made of melamine plastic, 0.125 inch thick, white with black center core. Provide the nameplate with a surface that is matte finished and that has square corners.. Accurately align lettering and engrave into the core. Provide nameplates that are at least 1.0 by 2.5 inches with a minimum lettering size of 0.25 inch high normal block style.

2.4 FACTORY TESTING

Submit a description of proposed field test procedures, including proposed date and steps describing each test, its duration and expected results, not less than 2 weeks prior to test date. Submit certified factory and field test reports, within 14 days following completion of tests. Provide reports that are certified and dated and that demonstrate that tests were successfully completed prior to shipment of equipment.

2.4.1 Prototype Factory Testing

A prototype of specified ATS is to be factory tested in accordance with UL 1008. In addition, perform factory tests on each ATS as follows:

a. Insulation resistance test to ensure integrity and continuity of entire system

b. Main switch contact resistance test.

c. Visual inspection to verify that each ATS is as specified.

d. Mechanical test to verify that ATS sections are free of mechanical hindrances.

e. Electrical tests to verify complete system electrical operation and to set up time delays and voltage sensing settings.

2.4.2 Factory Test Reports

Provide three certified copies of factory test reports from the manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

Installation must conform to the requirements of NFPA 70 and manufacturer's recommendation.

3.2 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING

Completion of the following requirements is mandatory prior to scheduling functional acceptance tests for the automatic transfer switch.

3.2.1 Performance of Acceptance Checks and tests

Complete as specified in paragraph entitled "Acceptance Checks and Tests". The Acceptance Checks and Tests are to be accomplished by the Testing organization as described in Section 26 08 00 APPARATUS INSPECTION AND TESTING.

3.2.2 Manufacturers O&M Information

The manufacturers O&M information required by the paragraph entitled "SD-10 Operation and Maintenance Data", is to be submitted to and approved by the Contracting Officer.

3.2.3 Test Equipment

Ensure all test equipment and instruments is on hand prior to scheduling field tests, or subject to Contracting Officer's approval, evidence must be provided to show that arrangements have been made to have the necessary equipment and instruments on site prior to field testing.

3.3 FIELD QUALITY CONTROL

Give Contracting Officer 15 days notice of dates and times scheduled for tests which require the presence of the Contracting Officer. The Contracting Officer will coordinate with the using activity and schedule a time that will eliminate or minimize interruptions and interference with the activity operations. The contractor is responsible for costs associated with conducting tests outside of normal working hours and with incorporating special arrangements and procedures, including temporary power conditions. The contractor provides labor, equipment, apparatus, including test load, and consumables required for the specified tests. Calibration of all measuring devices and indicating devices must be certified. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and start-up of the equipment specified under this section. The manufacturer's representative is to provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly components contained herein. Perform the following field tests in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.3.1 Automatic Transfer Switch Acceptance Checks and Tests

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate data with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Confirm correct application of manufacturer's recommended lubricants.

(4) Verify that manual transfer warnings are attached and visible.

(5) Verify tightness of all control connections.

(6) Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey is not required.

(7) Perform manual transfer operation.

(8) Verify positive mechanical interlocking between normal and alternate sources.

b. Electrical Tests

(1) Measure contact-resistance. Correct values that exceed 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

(2) Perform insulation-resistance on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole for one minute. Perform tests in both source positions.

(3) Verify settings and operations of control devices.

(4) Calibrate and set all relays and timers.

3.3.2 Functional Acceptance Tests

Functional Acceptance Tests must be coordinated with Section 26 32 15 ENGINE-GENERATOR SET STATIONARY 15-2500 KW, WITH AUXILIARIES.Functional Acceptance Test must be coordinated with Section 21 30 00 FIRE PUMPS. Include simulating power failure and demonstrating the following operations for each automatic transfer switch. Demonstrate in service that the automatic transfer switches are in good operating condition, and function not less than five times.

a. Perform automatic transfer tests:

(1) Simulate loss of normal/preferred power.

(2) Return to normal/preferred power.

(3) Simulate loss of emergency/alternate power.

(4) Simulate all forms of single-phase conditions.

b. Verify correct operation and timing of the following functions:

(1) Normal source voltage-sensing relays.

(2) Engine start sequence.

(3) Time delay upon transfer.

(4) Alternate source voltage-sensing relays.

(5) Automatic transfer operation.

(6) Interlocks and limit switch function.

(7) Time delay and retransfer upon normal power restoration.

(8) By-pass/isolation functional modes and related automatic transfer switch operations.

3.3.3 Infrared Scanning

After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after acceptance.

b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

c. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 TRAINING

Provide 4 hours of training to maintenance personnel on the proper operation, maintenance and adjustment of the automatic transfer switch. Coordinate this training with that of the generator equipment.

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SECTION 26 41 00

LIGHTNING PROTECTION SYSTEM

11/13

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SECTION 26 41 00

LIGHTNING PROTECTION SYSTEM
11/13

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

U.S. AIR FORCE (USAF)

AFI 32-1065	(2017) Grounding Systems

UL SOLUTIONS (UL)

UL 96	(2016) UL Standard for Safety Lightning Protection Components
UL 96A	(2023) UL Standard for Safety Installation Requirements for Lightning Protection Systems
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL Electrical Construction	(2012) Electrical Construction Equipment Directory

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-575-01	(2012) Lightning and Static Electricity Protection Systems

1.2 RELATED REQUIREMENTS

1.2.1 Verification of Dimensions

Confirm all details of work, verify all dimensions in field, and advise Contracting Officer of any discrepancy before performing work. Obtain

prior approval of Contracting Officer before making any departures from the design.

1.2.2 System Requirements

Provide a system furnished under this specification consisting of the latest UL Listed products of a manufacturer regularly engaged in production of lightning protection system components. Comply with NFPA 70, NFPA 780, and UL 96.

1.2.3 Lightning Protection System Installers Documentation

Provide documentation showing that the installer is certified with a commercial third-party inspection company whose sole work is lightning protection, or is a UL Listed Lightning Protection Installer. In either case, the documentation must show that they have completed and passed the requirements for certification or listing, and have a minimum of 2 years documented experience installing lightning protection systems for DoD projects of similar scope and complexity.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overall lightning protection system; G, DO

Each major component; G, DO

SD-06 Test Reports

Lightning Protection and Grounding System Test Plan; G, RO

Lightning Protection and Grounding System Test; G, RO

SD-07 Certificates

Lightning Protection System Installers Documentation; G, RO

Component UL Listed and Labeled; G, RO

Lightning protection system inspection certificate; G, RO

Roof manufacturer's warranty; G, RO

1.4 QUALITY ASSURANCE

In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" or "must" has been substituted for "should" wherever it appears. Interpret references in these standards to "authority having jurisdiction," or words of similar meaning, to mean Contracting Officer.

1.4.1 Installation Drawings

1.4.1.1 Overall System Drawing

Submit installation shop drawing for the overall lightning protection system. Include on the drawings the physical layout of the equipment (plan view and elevations), mounting details, relationship to other parts of the work, and wiring diagrams.

1.4.1.2 Major Components

Submit detail drawings for each major component including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions.

1.4.2 Component UL Listed and Labeled

Submit proof of compliance that components are UL Listed and Labeled. Listing alone in UL Electrical Construction, which is the UL Electrical Construction Directory, is not acceptable evidence. In lieu of Listed and Labeled, submit written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that items have been tested and conform to requirements and testing methods of Underwriters Laboratories.

1.4.3 Lightning Protection and Grounding System Test Plan

Provide a lightning protection and grounding system test plan. Detail both the visual inspection and electrical testing of the system and components in the test plan. Identify (number) the system test points/locations along with a listing or description of the item to be tested and the type of test to be conducted. As a minimum, include a sketch of the facility and surrounding lightning protection system as part of the specific test plan for each structure. Include the requirements specified in paragraph, "Testing of Integral Lightning Protection System" in the test plan.

1.4.4 Lightning Protection System Inspection Certificate

Provide certification from a commercial third-party inspection company whose sole work is lightning protection, stating that the lightning protection system complies with NFPA 780 and AFI 32-1065. Third party inspection company cannot be the system installer or the system designer. Alternatively, provide a UL Lightning Protection Inspection Master Label Certificate for each facility indicating compliance to NFPA 780 and AFI 32-1065. In either case, AFI 32-1065 takes precedence over NFPA 780, whether or not it is more stringent.

Inspection must cover every connection, air terminal, conductor, fastener, accessible grounding point and other components of the lightning protection system to ensure 100% system compliance. This includes witnessing the tests for the resistance measurements for ground rods with test wells, and for continuity measurements for bonds. It also includes verification of proper surge protective devices for power, data and telecommunication systems. Random sampling or partial inspection of a facility is not acceptable.

1.5 SITE CONDITIONS

Confirm all details of work, verify all dimensions in field, and advise Contracting Officer of any discrepancy before performing work. Obtain prior approval of Contracting Officer before changing the design.

PART 2 PRODUCTS

2.1 MATERIALS

Do not use a combination of materials that forms an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, provide conductors with protective coatings, such as tin or lead, or oversize conductors. Where a mechanical hazard is involved, increase conductor size to compensate for the hazard or protect conductors. When metallic conduit or tubing is provided, electrically bond conductor to conduit or tubing at the upper and lower ends by clamp type connectors or welds (including exothermic). All lightning protection components, such as bonding plates, air terminals, air terminal supports and braces, chimney bands, clips, connector fittings, and fasteners are to comply with the requirements of UL 96 classes as applicable.

2.1.1 Main and Bonding Conductors

NFPA 780 and UL 96 Class I, Class II, or Class II modified materials as applicable.

2.1.2 Copper Only

Provide copper conductors, except where aluminum conductors are required for connection to aluminum equipment.

2.2 COMPONENTS

2.2.1 Air Terminals

Provide solid air terminals with a blunt tip. Tubular air terminals are not permitted. Support air terminals more than 24 inches in length by suitable brace, supported at not less than one-half the height of the terminal.

2.2.2 Ground Rods

Provide ground rods made of copper-clad steel conforming to conform to UL 467. Provide ground rods that are not less than 3/4 inch in diameter and 10 feet in length. Do not mix ground rods of copper-clad steel or solid copper on the job.

2.2.3 Connections and Terminations

Provide connectors for splicing conductors that conform to UL 96A, class as applicable. Conductor connections can be made by clamps or welds (including exothermic). Provide style and size connectors required for the installation.

2.2.4 Connector Fittings

Provide connector fittings for "end-to-end", "Tee", or "Y" splices that conform to NFPA 780 and UL 96.

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM

Provide a lightning protection system that meets the requirements of NFPA 780. Lightning protection system consists of air terminals, roof conductors, down conductors, ground connections, grounding electrodes and ground ring electrode conductor. Routing and protection of sleeves shall be as indicated on EG sheets. Bond secondary conductors with grounded metallic parts within the building. Make interconnections within side-flash distances at or below the level of the grounded metallic parts.

All bonding identified on EG sheets shall be included in the integral system, including roof devices (such as tubular daylighting devices and exhaust vents) under the zone of protection.

The zone of protection for all lightning protection systems in this contract shall be based on a striking distance not exceeding 100 feet (30 m) due to the housing of hazardous and/or explosive materials.

In accordance with UFC 3-575-01 Paragraph 3-5.7, all doors and windows in the hazardous area will be bonded to the lightning protection system.

3.1.1 Roof-Mounted Components

Coordinate with the roofing manufacturer and provide certification that the roof manufacturer's warranty is not violated by the installation methods for air terminals and roof conductors. All surfaces shall be properly prepared for building-attached components in accordance with the manufacturer requirements. This area is subject to snow and/or constant wind; for adhesive attachment of components, ensure a section of roofing material (minimum dimensional area of 1 square foot) is first glued to the roof and then the air terminal is glued to it unless the roof manufacturer recommends another solution.

3.1.1.1 Air Terminals

Use adhesive shoes with adhesive approved by the roof manufacturer when installing air terminals on "rubber" (EPDM) type roofs. This area is subject to snow and/or constant wind; ensure that a section of roofing material (minimum dimensional area of 1 square foot) is first glued to the roof and then the air terminal is glued to it unless the roof manufacturer recommends another solution. Use a standing seam base for installation of air terminals on a standing seam metal roof that does not produce any roof penetrations.

3.1.1.2 Roof Conductors

Use adhesive shoes with adhesive approved by the roof manufacturer when installing roof conductors on "rubber" (EPDM) type roofs. Use a standing seam base for installation of roof conductors on a standing seam metal roof that does not produce any roof penetrations.

3.1.2 Down Conductors

Protect exposed down conductors from physical damage as required by NFPA 780. Use Schedule 80 PVC to protect down conductors. Paint the Schedule 80 PVC to match the surrounding surface with paint that is approved for use on PVC.

3.1.3 Ground Connections

Protect exposed down conductors from physical damage as required by NFPA 780. Use Schedule 80 PVC to protect down conductors. Paint the Schedule 80 PVC to match the surrounding surface with paint that is approved for use on PVC. Down conductors are to be concealed within the wall cavities where indicated on EG sheets. In accordance with NFPA 780 Sections 7.2.1 and 7.3.4.2, down conductors shall not be routed through areas identified as hazardous in the E-### sheets, nor shall structural systems within hazardous spaces be used as a substitute for down conductors in these areas.

3.1.4 Grounding Electrodes

Extend driven ground rods vertically into the existing undisturbed earth for a distance of not less 10 feet. Set ground rods not less than 3 feet nor more than 8 feet, from the structure foundation, and at least beyond the drip line for the facility. After the completed installation, measure the total resistance to ground using the fall-of-potential method described in IEEE 81. Maximum allowed resistance of a driven ground rod is 10 ohms, under normally dry conditions when a ground ring electrode is not used. Contact the Contracting Officer for direction on how to proceed when two of any three ground rods, driven not less than 10 feet into the ground, a minimum of 10 feet apart, and equally spaced around the perimeter, give a combined value exceeding 25 ohms immediately after having driven. For ground ring electrode, provide bare stranded copper cable of the size indicated on sheet EG600 for the hangar ground ring and for the ancillary structures.. Lay ground ring electrode around the perimeter of the structure in a trench not less than 3 feet nor more than 8 feet from the nearest point of the structure foundation, and at least beyond the drip line for the facility. Install ground ring electrode to a minimum depth of 30 inches. Install a ground ring electrode in earth undisturbed by excavation, not earth fill, and do not locate beneath roof overhang, or wholly under paved areas or roadways where rainfall cannot penetrate to keep soil moist in the vicinity of the cable.

3.1.5 Sideflash Secondary Bonding Distance

In accordance with UFC 3-575-01 Paragraph 3-5.7, the sideflash secondary bonding distance will be extended from the 6 feet required by NFPA 780 to 10 feet.

3.2 APPLICATIONS

3.2.1 Nonmetallic Exterior Walls with Metallic Roof

Bond metal roof sections together which are insulated from each other so that they are electrically continuous, having a surface contact of at least 3 square inches.

3.2.2 Personnel Ramps and Covered Passageways

Place a down conductor and a driven ground at one of the corners where the ramp connects to each building or structure. Connect down conductor and driven ground to the ground ring electrode or nearest ground connection of the building or structure. Where buildings or structures and connecting ramps are clad with metal, separately bond the metal of the buildings and ramps to a down conductor as close to grade as possible.

3.3 INTERFACE WITH OTHER STRUCTURES

3.3.1 Fences

Bond metal fence and gate systems to the lightning protection system whenever the fence or gate is within 6 feet of any part of the lightning protection system in accordance with ANSI C2.

3.4 RESTORATION

Where sod has been removed, place sod as soon as possible after completing the backfilling. Restore, to original condition, the areas disturbed by trenching, storing of dirt, cable laying, and other work. Overfill to accommodate for settling. Include necessary topsoil, fertilizing, liming, seeding, sodding, sprigging or mulching in any restoration. Maintain disturbed surfaces and replacements until final acceptance.

3.5 FIELD QUALITY CONTROL

3.5.1 Lightning Protection and Grounding System Test

Test the lightning protection and grounding system to ensure continuity is not in excess of 1 ohm and that resistance to ground is not in excess of 10 ohms. Provide documentation for the measured values at each test point. Test the ground rod for resistance to ground before making connections to the rod. Tie the grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Include in the written report: locations of test points, measured values for continuity and ground resistances, and soil conditions at the time that measurements were made. Submit results of each test to the Contracting Officer.

3.6 INTERCONNECTION OF METAL BODIES

Metal bodies of conductance shall be protected if not within the zone of protection of an air terminal. Metal bodies of conductance having an area of 400 square inch or greater or a volume of 1000 cubic inch or greater shall be bonded to the lightning protection system using main size conductors and a bonding plate having a surface contact area of not less than 3 square inch. Provisions shall be made to guard against the corrosive effect of bonding dissimilar metals. Metal bodies of inductance shall be bonded at their closest point to the lightning protection system using secondary bonding conductors and fittings. A metal body that exceeds 5 feet in any dimension, that is situated wholly within a building, and that does not at any point come within 6 feet of a lightning conductor or metal connected thereto shall be independently grounded.

3.7 INSPECTION

The lightning protection system will be inspected by the Contracting

Officer to determine conformance with the requirements of this specification. No part of the system shall be concealed until so authorized by the Contracting Officer.

3.8 UL MASTER LABEL INSPECTION

A lightning protection system inspection shall made by a UL representative to determine conformance with the requirements of NFPA 780, UL 467, and UL 96A at no additional cost to the Government. The Contractor shall correct any deficiencies in the lightning protection system reported by the UL representative at no additional cost to the Government. A UL Lightning Protection System Master Label Inspection Certificate shall be provided for the hangar and ancillary structures after all reported deficiencies have been corrected.

-- End of Section --

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GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B1.20.1	(2013; R 2018) Pipe Threads, General Purpose (Inch)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.39	(2020) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A194/A194M	(2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B3	(2013; R 2024) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM B418	(2016a; R2021) Standard Specification for Cast and Wrought Galvanic Zinc Anodes
ASTM B843	(2018) Standard Specification for Magnesium Alloy Anodes for Cathodic Protection
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials
ASTM D1248	(2016) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D2028/D2028M	(2015; R 2021) Cutback Asphalt (Rapid-Curing Type)
ASTM D3381/D3381M	(2018) Standard Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 15589-2	(2012) Petroleum, Petrochemical and Natural Gas Industries - Cathodic Protection of Pipeline Transportation Systems - Part 2: Offshore Pipelines

NACE INTERNATIONAL (NACE)

NACE SP0106	(2018) Control of Internal Corrosion in Steel Pipelines and Piping Systems
NACE SP0176	(2007) Corrosion Control of Submerged Areas of Permanently Installed Steel Offshore Structures Associated with Petroleum Production
NACE SP0177	(2019) Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
NACE SP0186	(1986; R 2007) Application of Cathodic Protection for External Surfaces of Steel Well Casings
NACE SP0188	(1999; R 2006) Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
NACE SP0193	(2016) Application of Cathodic Protection to Control External Corrosion of Carbon Steel On-Grade Storage Tank Bottoms
NACE SP0200	(2014) Standard Practice Steel-Cased

	Pipeline Practices
NACE SP0285	(2021) External Corrosion Control of Underground Storage Tank Systems by Cathodic Protection
NACE SP0286	(1997; R 2007) Standard Practice Electrical Isolation of Cathodically Protected Pipelines
NACE SP0607	(2007) Petroleum and Natural Gas Industries — Cathodic Protection of Pipeline Transportation Systems — Part 2: Offshore Pipelines
NACE SP21424	(2018) Alternating Current Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation and Monitoring
NACE TPC 11	(2008) A Guide to the Organization of Underground Corrosion-Control Coordinating Committees

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C119.1	(2023) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-18001	(1993) Anodes, Sacrificial Zinc Alloy

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and

	Rubber Insulating Tape
UL 514A	(2013; Reprint Jun 2022) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint May 2020) Conduit, Tubing and Cable Fittings

1.2 DEFINITIONS

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. Each form can be identified by visual observation, although, in some cases, magnification is required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. Examination before cleaning is particularly desirable. Cathodic Protection is a method used to control corrosion.

1.2.1 Cathodic Protection

Cathodic Protection (CP) is an electrochemical (half electrical and half chemical) method used to control corrosion of buried or submerged metallic structures. It prevents corrosion by making the protected structure a cathode by installing a more anodic metal (sacrificial or galvanic) anode or a metallic (impressed current) anode connected to a Direct Current (DC) power source. When the proper amount of current is applied to the structure, it becomes a cathode. Since all corrosion occurs at the anode, the structure no longer corrodes. The electrons move in the metallic path (electrical). Reduction (chemical) reactions occur at the surface of the cathode resulting in a hydrogen coating and more alkaline environment. Oxidation (chemical) reactions occur at the surface of the anode resulting in corrosion and a more acidic environment. After a CP system is installed and adjusted to provide adequate protection, the hydrogen coats the defects in the coating and polarizes in the negative direction (to a copper/copper sulfate reference electrode) over time the current and potentials remain relatively stable; changes in currents or potentials indicate a problem. An error-free measurement of negative 850 millivolts DC or more negative to the copper/copper-sulfate reference electrode proves the structure is a cathode and corrosion has been mitigated.

1.2.2 Corrosion

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. Each form can be identified by visual observation, although, in some cases, magnification is required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. Examination before cleaning is particularly desirable. Some of the eight forms of corrosion are unique, but all of them are more or less interrelated.

The eight forms of corrosion are: (1) Uniform Attack, (2) Galvanic or Two-Metal Corrosion, (3) Crevice Corrosion, (4) Pitting Corrosion, (5) Intergranular Corrosion, (6) Selective Leaching, (7) Erosion Corrosion, and (8) Stress Corrosion Cracking. This listing is arbitrary but covers practically all corrosion failures and problems. The forms are not listed in any particular order of importance. Below, the eight forms of

corrosion are discussed in terms of their characteristics, mechanisms, and preventive measures. Hydrogen damage, although not a form of corrosion, often occurs indirectly as a result of corrosive attack and is, therefore, included in this discussion.

1.2.3 Alternating Current (AC) Corrosion

AC corrosion occurs when there is a source of AC current, typically from a high voltage overhead AC (OHAC) power-line, when there is a low soil resistivity - typically less than 5,000 ohm-cm and there is a very small coating holidays. The AC corrosion pits typically have a tubercle of corrosion product at the pit. AC interference study modeling software can determine the mitigation solution to solve this problem. Typically, AC Corrosion mitigation is done in conjunction with high AC potentials and fault current mitigation.

1.2.4 AC Interference

AC interference occurs when a pipeline parallels a high-voltage overhead AC (OHAC) power-line. An interference study is required when this situation occurs as AC interference can cause high AC potentials along the pipeline (safety), can cause a fault condition between the pipeline and power-line and could cause AC corrosion to occur. The pipeline coating when exposed can have blisters/bubbles caused by the excessive AC. The interference study will use modeling software to determine what combination of interference may be occurring (if any) and provide the mitigation solution to solve the problem.

1.2.5 Uniform Attack

Uniform attack is the most common form of corrosion. It is normally characterized by a chemical or electrochemical reaction that proceeds uniformly over the entire exposed surface or over a large area. The metal becomes thinner and eventually fails. For example, a piece of steel or zinc immersed in dilute sulfuric acid normally dissolves at a uniform rate over its entire surface. A sheet iron roof shows essentially the same degree of rusting over its entire outside surface.

Uniform attack, or general overall corrosion, represents the greatest destruction of metal on a tonnage basis. This form of corrosion, however, is not of great concern from a technical standpoint, because the life of equipment can be accurately estimated on the basis of comparatively simple tests. Merely immersing specimens in the fluid involved is often sufficient. Uniform attack can be prevented or reduced by (1) materials, such as coatings, that reduce contact between metal and electrolytes, (2) inhibitors, or (3) CP.

1.2.6 Galvanic or Two-Metal Corrosion

A potential difference usually exists between two dissimilar-metals when they are immersed in a corrosive or conductive solution. If these metals are placed in contact (or otherwise electrically connected), this potential difference produces electron flow between them. Corrosion of the less corrosion-resistant metal is usually increased, and attack of the more resistant material is decreased, compared to the behavior of these metals when they are not in contact. The less resistant metal becomes anodic and the more resistant metal becomes cathodic. Usually the cathode or cathodic metal corrodes very little or not at all in this type of couple. Because of the electric currents and dissimilar-metals involved,

this form of corrosion is called galvanic, bi-metallic or two-metal, corrosion. Galvanic corrosion is restricted to electrochemical corrosion caused by dissimilar-metal effects. It is electrochemical corrosion, but this document must restrict the term galvanic to dissimilar-metal effects for purposes of clarity.

1.2.7 Crevice Corrosion

Intense localized corrosion frequently occurs within crevices and other shielded areas on metal surfaces exposed to corrosives. This type of attack is usually associated with small volumes of stagnant solution caused by holes, gasket surfaces, lap joints, surface deposits, and crevices under bolt and rivet heads. As a result, this form of corrosion is called crevice corrosion or, sometimes, deposit or gasket corrosion.

1.2.8 Pitting Corrosion

Pitting is a form of extremely localized attack that results in holes in the metal. These holes may be small or large in diameter, but in most cases they are relatively small. Pits are sometimes isolated or so close together that they look like a rough surface. Generally a pit may be described as a cavity or hole with the surface diameter about the same as or less than the depth. Pitting is one of the most destructive and insidious forms of corrosion. It causes equipment to fail because of perforation with only a small percent weight loss of the entire structure. It is often difficult to detect pits because of their small size and because the pits are often covered with corrosion products. In addition, it is difficult to measure quantitatively and compare the extent of pitting because of the varying depths and numbers of pits that may occur under identical conditions. Pitting is also difficult to predict by laboratory tests. Sometimes the pits require a long time (several months or a year) to show up in actual service. Pitting is particularly vicious because it is a localized and intense form of corrosion, and failures often occur with extreme suddenness.

1.2.9 Intergranular Corrosion

Grain boundary effects are of little or no consequence in most applications or uses of metals. If a metal corrodes, uniform attack results since grain boundaries are usually only slightly more reactive than the matrix. However, under certain conditions, grain interfaces are very reactive and intergranular corrosion results. Localized attack at and adjacent to grain boundaries, with relatively little corrosion of the grains, is intergranular corrosion. The alloy disintegrates (grains fall out) or loses its strength. Intergranular corrosion can be caused by impurities at the grain boundaries, enrichment of one of the alloying elements, or depletion of one of these elements in the grain-boundary areas. Small amounts of iron in aluminum, wherein the solubility of iron is low, have been shown to segregate in the grain boundaries and cause intergranular corrosion. It has been shown that, based on surface tension considerations, the zinc content of a brass is higher at the grain boundaries. Depletion of chromium in the grain-boundary regions results in intergranular corrosion of stainless steels.

1.2.10 Selective Leaching

Selective leaching is the removal of one element from a solid alloy by corrosion processes. The most common example is the selective removal of zinc in brass alloys (dezincification). Similar processes occur in other

alloy systems in which aluminum, iron, cobalt, chromium, and other elements are removed. Selective leaching is the general term to describe these processes, and its use precludes the creation of terms such as de-aluminumification, de-cobaltification. Parting is a metallurgical term that is sometimes applied, but selective leaching is preferred.

1.2.11 Erosion Corrosion

Erosion corrosion is the acceleration or increase in rate of deterioration or attack on a metal because of relative movement between a corrosive fluid and the metal surface. Generally, this movement is quite rapid, and mechanical wear effects or abrasion are involved. Metal is removed from the surface as dissolved ions, or it forms solid corrosion products, which are mechanically swept from the metal surface. Sometimes, movement of the environment decreases corrosion, particularly when localized attack occurs under stagnant conditions; this is not erosion corrosion because deterioration is not increased. Erosion corrosion is characterized in appearance by grooves, gullies, waves, rounded holes, and valleys and usually exhibits a directional pattern. In many cases, failures because of erosion corrosion occur in a relatively short time, and they are unexpected largely because evaluation corrosion tests were run under static conditions or because the erosion effects were not considered.

1.2.12 Stress-Corrosion Cracking

Stress-corrosion cracking refers to cracking caused by the simultaneous presence of tensile stress and a specific corrosive medium. Many investigators have classified all cracking failures occurring in corrosive media as stress-corrosion cracking, including failures due to hydrogen embrittlement. However, these two types of cracking failures respond differently to environmental variables. To illustrate, CP is an effective method for preventing stress-corrosion cracking; however, hydrogen-embrittlement may be caused when excessive current is applied, especially on stainless steel. Hence, the importance of considering stress-corrosion cracking and hydrogen embrittlement as separate phenomena is obvious. During stress-corrosion cracking, the metal or alloy is virtually unattacked over most of its surface, while fine cracks progress through it. This cracking phenomenon has serious consequences, since it can occur at stresses within the range of typical design stress.

1.2.13 Exothermic Welding

Exothermic welding is used in CP to connect a copper wire to a metallic structure, usually steel or cast-iron. It is a pyrotechnic composition of copper oxide, aluminum powder and magnesium powder. The magnesium powder is ignited with a spark gun or electronic ignition equipment. The aluminum powder serves as fuel, and melts the copper oxide, which bonds the wire to the structure. Although not explosive, it can create brief bursts of heat and high temperature in a small area.

1.2.14 Error-Free

Potential measurement error due to a voltage drop caused by current flowing through a resistor (the electolyte) between the reference electrode and the protected structure.

1.3 ADMINISTRATIVE REQUIREMENTS

After award of the contract, but prior to commencement of any work at the

site, meet with the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Develop a mutual understanding relative to the administration of the value engineering, the safety program, preparation of the schedule of prices or the earned value report. Review shop drawings, and other submittals, scheduling programming, execution of the work, and clear expectations of the "Interim Department of Defense (DD) Form 1354" submittal. Major subcontractors who will engage in the work must also attend.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preconstruction Survey

SD-02 Shop Drawings

Drawings; G, RO

Isolation flange kits

Anode junction boxes, bonding boxes, and test stations

Joint bonds

Contractor's Modifications; G, RO

SD-03 Product Data

Qualifications

Equipment; G, RO

Anodes; G, RO

Anode junction boxes, bonding boxes, and test stations

Dielectric unions

Wires

Cable and wire

Casings, isolation, and seals

Shunts

Permanent reference electrodes; G, RO

Spare Parts

SD-06 Test Reports

Tests and Measurements; G, RO

Contractor's Modifications; G, RO

SD-10 Operation and Maintenance Data

Cathodic Protection System; G, RO

Training Course; G, RO

Cathodic Protection System, Data Package 5; G, RO

SD-11, Closeout Submittals

Initial Cathodic Protection System Field Testing; G, RO

One Year Warranty Period Cathodic Protection System Field Test Report; G, RO

Final Cathodic Protection System Field Test Report; G, RO

1.4.1 Material and Equipment Manufacturer Data

DATE	ISSUE NO.	REQUEST DATE	REQUESTED BY	REQUEST REF. NO.
MANUFACTURER NAME				
DESCRIPTION OF EQUIPMENT				

1.5 MAINTENANCE MATERIAL SUBMITTALS

1.5.1 Spare Parts

After approval of shop drawings, furnish spare parts data for each different item of material and equipment specified. The data must include a complete list of parts, special tools, and supplies, with current unit prices and source of supply.

After approval of shop drawings, furnish revised spare parts for any changes made from original submittal. One spare anode of each type must be furnished. In addition, supply information for material and equipment replacement for all other components of the complete system, including anodes, cables, splice kits and connectors, corrosion test stations, and any other components not listed above. Furnish one reference electrode on a hand reel with 350 feet of conductor, . Demonstrate use of furnished equipment in actual tests during the training course. Provide a description of equipment of the pipe-to-soil protected structure and foreign structures at electrical isolation between the utility supplier and the facility piping.

1.5.2 Extra Materials

Furnish one reference electrode on a hand reel with 350 feet of conductor, . Demonstrate use of furnished equipment in actual tests during the training course. Provide a description of equipment of the pipe-to-soil protected structure and foreign structures at electrical isolation between the utility supplier and the facility piping. Include a description of the equipment and measurement of the pipe-to-soil potentials, anode voltage, anode current and soil condition.

1.6 QUALITY CONTROL

1.6.1 Regulatory Requirements

Obtain the services of a corrosion expert to supervise, inspect, and test the installation and performance of the cathodic protection system. The term "corrosion expert" refers to a person, who by thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of buried or submerged metallic structures.

1.6.2 Qualifications

The corrosion expert must be accredited or certified by NACE International, as a CP-4 CP Specialist or be a NACE International certified Corrosion Specialist or a registered professional engineer who has certification or licensing that includes education and experience in CP of the type of CP system being installed. The corrosion expert must have not less than five years of experience in the type of CP for buried or submerged metallic structures under this contract. Submit evidence of qualifications of the corrosion expert including their name and qualifications certified in writing to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager prior to the start of construction. Certification must be submitted giving the name of the firm, the number of years of experience, and a list of not less than five of the firm's installations, three or more years old, that have been tested and found satisfactory.

1.6.3 Services of Corrosion Expert

The "corrosion expert" must make a minimum of three visits to the project site. The first of these visits will include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used and reporting to the contractor the type of CP required (GACP or ICCP). Once the submittals are approved and the materials delivered, the "corrosion

expert" will revisit the site to verify the materials meet submittal requirements, ensure the contractor understands installation practices and that the contractor is capable and qualified to complete the installation.

The "corrosion expert" will be available (but not necessarily be onsite the entire time) during the installation of the CP system to answer questions, approve any changes or additions required during construction, or to provide recommendations as required. The third visit is to complete the training and demonstrations to applicable personnel on proper testing and maintenance techniques and to complete testing the installed CP systems to ensure it has been installed properly and meets adequate CP criteria. An additional visit is required if the One-Year-Warranty-Period-Testing is required.

1.7 DELIVERY, STORAGE AND HANDLING

Storage area for corrosion materials will be designated by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. If materials are not stored in a building, tarps or similar protection must be used to protect material from inclement weather. Resack and add backfill to packaged anodes that are damaged as a result of improper handling or exposure to rain.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

1.8.2 Existing Conditions

Prior to start of any onsite construction activities, perform a Preconstruction Survey of the project site with the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager, and take photographs showing existing environmental conditions in and adjacent to the site. Submit a report for the record. Include in the report a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the contractor's assigned storage area and access route(s), as applicable. The Contractor and the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager will sign this survey report upon mutual agreement regarding its accuracy and completeness. Protect those environmental features included in the survey report and any indicated on the drawings, regardless of interference that their preservation may cause to the work under the Contract.

1.9 WARRANTY

Provide equipment items that are supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Corrosion Control System Description

A corrosion control system consists of several systems which work together to mitigate corrosion on buried or submerged metallic structures. Failure to comply with the requirements of any one of these systems may result in inadequate corrosion control and premature failure of the structure being protected. Each system's guide specifications must be included in the design and installation of a complete corrosion control system and must be adhered to in the design and execution of the corrosion control of a structure being protected. Determination of Need for CP must be made by government requirements and policy directives.

a. Construction Design Requirements (CDR) for protected structures are found in the UFGS for the structure being protected. For underground storage tanks NACE SP0285, aboveground storage NACE SP0193, fuel storage piping Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT), leak detection systems Section 33 01 50.31 LEAK DETECTION FOR FUELING SYSTEMS, offshore pipelines NACE SP0607 and ISO 15589-2, offshore structures and NACE SP0176, pipeline casings structures (railroad, highway and water crossing) NACE SP0200 and for well casings NACE SP0186.

b. Coating Systems (CS) are a critical factor in performance of a GACP system. All coatings, including coatings in structure guide specifications and Green Seal (GS) coatings, must be compatible with the structure and the CP system, and have high disbondment capabilities. A high resistance to cathodic disbondment is critical for long term service life of coatings on buried or submerged metallic structures under CP. For paints and coatings refer to Section 09 90 00 PAINTS AND COATINGS, and for discontinuity (Holiday) testing of new protective coatings on conductive substrates refer to NACE SP0188.

c. Mechanical Damage Systems (MDS) such as bedding and rock control barriers normally included in Structure GS may be required by design for some locations. Electrical Isolation is required for all galvanic anode CP systems. For an Electrical Isolation System (EIS) refer to NACE SP0286.

d. An Electrical Continuity System (ECS) of the protected structure is critical to the operation of the CP system. The types of joints such as bonding and couplings are normally included in Structure GS, this is particularly important to nonwelded pipelines to allow sufficient CP current to conduct to the entire structure.

e. Stray Current (Interference) Systems must be considered in design, monitored during construction, and interference testing must be completed during the final testing. Design must consider all other cathodic protection systems which may affect other systems or systems which may affect the project, including foreign systems. All foreign systems must be contacted for information and notification and any joint testing which may be required. Corrosion Coordinating Committees may exist. Reference NACE TPC 11.

f. Pipelines that parallel overhead high voltage AC transmission power systems are subject to induced AC. Induced AC has several potential

adverse impacts on the safety of personnel and pipeline integrity. Assuming that these conditions exist, there are several measures that can be taken to mitigate the induced AC present on a pipeline. These induced AC mitigation strategies are detailed in various international standards including NACE SP0177.

g. Galvanic Anode CP Monitoring System is a solution for remote monitoring (and optionally controlling) different kinds of galvanic anode CP applications, mainly to protect underground pipelines used in oil and gas distribution systems, but the same system can be used to monitor other galvanic anode CP applications like tank farms and oil platforms. These Monitoring Systems are detailed in various international standards including NACE TPC 11.

h. When a project is connecting to an existing infrastructure with CP the design must be compatible with the existing structure(s) CP system. Existing structures may have Impressed Current CP (ICCP) Anode Systems using Remote Anode Systems, Deep Anode Systems, Linear Anode Systems, or Distributed Anode Systems. Existing structures may also have Galvanic CP (GACP) Systems which may be distributed or remote. Existing structures might not have CP. They may use alternative methods of corrosion mitigation instead of CP such as Inhibitor System/Internal Corrosion Control. For control of internal corrosion in steel pipelines and piping systems refer to NACE SP0106. Due to the limited voltage and current of galvanic anodes the protected structure must be coated and isolated from other structures.

i. A highly dielectric bonded coating is required to attain adequate CP. Unbonded coatings block the protective current from the pipeline or structure and must not be used with CP. Failure to isolate other metallic structures will result in loss of protection. Isolation from other metallic structures must be maintained.

j. Continuity of the structure with low resistance is crucial to proper operation of a galvanic anode system. All joints must be continuous or be bonded to both sides of the joint.

k. A conductive electrolyte is required to allow current flow from the galvanic anodes. Use of galvanic anode systems are normally restricted to electrolytes with resistivities below 30,000 ohm-cm. Small well coated structures such as coated valves, tees and elbows have very high resistance to earth in high resistance soils. Galvanic anodes in electrolytes over 30,000 ohms also have very high resistance to earth. High circuit resistance with the low voltage of galvanic anodes will not allow sufficient current to meet instant off or depolarization criteria. Additional anodes under these conditions will not noticeably increase the current applied to the structure. Reference SP0169 for criteria in high resistance electrolytes.

2.1.2 Design Requirements

2.1.2.1 Electrical Isolators

Isolators are required to isolate the protected structure from any other structure. Provide isolators at all locations where the indicated protected structure contact any other metallic structure. Provide locations and detailed drawings of required installations. Include any requirements for lightning protection, test stations, surge protection, or other requirements and include locations and details in design drawings.

2.1.2.2 Anode and Bond Wires

Provide a minimum of 5 magnesium anodes with an unpackaged weight of 10 pounds at uniform distances along the metallic pipelines. Use a minimum of 3 test stations for these anodes. Provide these anodes in addition to anodes for the pipe under concrete slab and casing requirements. For each cathodic system, provide metallic components and structures that are electrically continuous by installing bond wires between the various structures. Bonding of existing buried structures may also be required to preclude detrimental stray current effects and safety hazards. Return stray current to its source without damaging structures intercepting the stray current. Provide electrical isolation of underground facilities in accordance with acceptable industry practice. All tests must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

2.1.2.3 Surge Protection

Install approved zinc grounding cells or sealed weatherproof lightning and surge arrestor devices across isolation flanges or fittings installed in underground piping as indicated on the drawings. Provide gapless, self-healing, solid state type arrestor. Provide zinc anode composition conforming to ASTM B418, Type II. Provide number 4 AWG copper lead wires with High Molecular Weight Polyethylene (HMWPE) insulation. Zinc grounding cells must be prepackaged in backfill install as detailed on the drawings. Lightning arrestors or zinc grounding cells are not required for isolation flanges on metallic components used on non-metallic piping systems.

2.1.2.4 Non-metallic Pipe System

In the event pipe other than metallic pipe is approved and used in lieu of metallic pipe, protect all metallic components of this pipe system with CP. Submit detailed drawings of CP for each component to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager for approval within 45 days after date of receipt of notice to proceed, and before commencement of any work.

2.1.2.5 Coatings

Provide coatings for metallic components as required for metallic fittings. Complete and test protective coating on each metallic component (such as valves, hydrants and fittings). Provide coating as required for underground metallic pipe. Each test must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Select, apply, and inspect coatings as specified in these specifications. The use of non-metallic pipe does not change other requirements of the specifications. Submit any deviations due to the use of non-metallic pipe for approval.

2.1.2.6 Tracer Wire

When a non-metallic pipeline is used to extend or add to an existing metallic line, exothermic-weld No. 8 AWG copper wire with THHN insulation to the existing metallic line and run the length of the new non-metallic line. Use this wire as a locator tracer wire and to maintain continuity to any future extensions of the pipeline.

2.1.2.7 Drawings

Submit six copies of detail drawings consisting of a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, contractor's modifications, results of system design calculations including soil-resistivity, installation instructions and certified test data showing location of anodes and stating the maximum recommended anode current output density. Include in the detail drawings complete wiring and schematic diagrams, isolation fittings, test stations, permanent reference electrodes and bonding and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. Reference locations to two permanent facilities or mark points. Provide one electronic PDF copy and digital photos of the completed installation.

2.1.2.8 Summary of Services Required

Include the following scope of services:

a. Close-interval potential surveys,

b. CP Installation System,

c. System testing,

d. Casing corrosion control,

e. Interference testing,

f. Training,

g. Operating and maintenance manual,

h. Isolation testing and bonding testing,

i. Coating and holiday testing.

2.1.2.9 Tests of Components

Perform a minimum of four tests at each metallic component in the piping system. Two measurements must be made directly over the anodes and the other two tests must be over the outer edge of the component, but at the farthest point from the anodes. Provide a field drawing showing the component, the structure, all components of the CP system and their relationship to each other. Also provide a narrative describing how the CP system will work and the testing at each component. Components requiring CP must include but not be limited to the following:

a. Pipes beneath the floor slab or foundations.

b. Post Indicator Valve (PIV).

c. Shutoff valves.

d. Metallic pipes extended from aboveground locations.

e. Connectors or change-of-direction devices.

f. Metallic pipe components or sections.

g. Backflow preventers.

h. Culverts.

i. Casings.

2.1.2.10 Electrical Potential Measurements

Make all potential tests at a minimum of 10 foot intervals witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Provide submittals identifying test locations on separate drawings, showing all metal to be protected and all CP equipment. Distinguish and identify test points, equipment, and protected metal.

2.1.2.11 Typical Metallic Components on Non-metallic Systems

2.1.2.11.1 Metallic Components

As a minimum, protect each metallic component with two galvanic anodes. This number of anodes is required to achieve minus 850 millivolts "instant off" potential on the metallic area and at the same time not provide overvoltage above 1200 millivolts "instant off." As a minimum, the galvanic anode unpackaged weight must be 9 pounds. Locate the galvanic anodes on each side of the metallic component and route through a test station.

2.1.2.11.2 Fire Hydrants

Provide fire hydrant pipe components with a minimum of two anodes. These galvanic anodes must have an unpackaged weight of 500 pounds.

2.1.2.11.3 Pipe Beneath Concrete Slab

Pipe beneath concrete slab must have a minimum of 3 galvanic anodes. These galvanic anodes must have an unpackaged weight of 9 pounds. Pipe beneath concrete slab must have 2 permanent reference electrodes located beneath the slab. Locate one permanent reference electrode where the pipe enters the concrete slab. Route all conductors to a test station.

2.1.2.11.4 Valves

Protect each valve with 1 galvanic anodes. The galvanic anode must have an unpackaged weight of 9 pounds.

2.1.2.11.5 Metallic Pipe Component or Section

Protect each section of metallic pipe with 2 galvanic anodes. The galvanic anodes must have an unpackaged weight of 9 pounds.

2.1.2.11.6 Connectors or Change-of-Direction Devices

Protect each change-of-direction device with 2 galvanic anodes. The galvanic anode must have an unpackaged weight of 9 pounds.

2.1.2.12 Metallic Component Coating

Coatings for metallic components will be required for metallic fittings as

indicated. These metallic fittings will include fire hydrants, tees, elbows, and valves. Coatings must be selected, applied, and inspected as specified in the coating specifications referenced and be compatible with the structure being protected. All coatings must be in accordance with all applicable Federal, State, and local regulations. Unbonded coatings must not be used with CP.

2.1.2.13 Location of Test Stations

Provide test stations of the type and location shown and curb box mount. Provide buried isolation joints with test wire connections brought to a test station. Reference all test stations with GPS coordinates. Unless otherwise shown, locate other test stations as follows:

a. At 1,000-foot intervals or less.

b. Where the pipe or conduit crosses any other metal pipe.

c. At both ends of casings under roadways and railways.

d. Where both sides of an isolation joint are not accessible above ground for testing purposes.

2.1.2.14 Electrical Isolation of Structures

As a minimum, provide isolating flanges or unions at the following locations:

a. Connection of new metallic piping or components to existing piping.

b. Pressure piping beneath floor slab to a building.

Provide isolation at metallic connection of all lines to existing system and where connecting to a building. Additionally, provide isolation between water or gas line; and foreign pipes that cross the new lines within 10 feet. Install isolation fittings, including isolating flanges and couplings, aboveground or in a concrete pit.

2.1.2.14.1 Gas Distribution Piping

Provide electrical isolation at each building riser pipe to the pressure regulator, at all points where a short to another structure or to a foreign structure may occur, and at other locations as indicated on the drawings.

2.1.2.14.2 Isolation Joint Testing

An isolator checker or insulation tester will be used for isolation or insulating joint (flange or dielectric) electrical testing.

2.1.2.14.3 Underground Structure Coating

This coating specification takes precedence over any other project specification and drawing notes, whether stated or implied, and also applies to the pipeline or tank supplier. Variance in coating quality is not allowed by the contractor or Base Construction Representative without the written consent of the designer. All underground metallic pipelines and tanks to be cathodically protected must have a high quality factory-applied coating. This includes all carbon steel, cast-iron and

ductile-iron pipelines or vessels. Select, apply, and inspect coatings as specified. If non-metallic pipelines are installed, coat all metallic fittings on pipe sections in accordance with this specification section.

a. The nominal coating thickness for the metallic pipe joint or other component coating must be 24 mils, plus or minus 5 percent.

b. Apply pipe and joint coating for factory applied or field repair material as recommended by the manufacturer. Coating must be one of the following:

(1) Continuously extruded polyethylene and adhesive coating system.
(2) Polyvinyl chloride pressure-sensitive adhesive tape.
(3) High density polyethylene/bituminous rubber compound tape.
(4) Butyl rubber tape.
(5) Coal tar epoxy.

2.1.2.14.4 Field Joints

Coat all field joints with materials compatible with the pipeline coating compound. Apply the joint coating material to an equal thickness as the pipeline coating. Do not use unbonded coatings for these buried metallic components. This includes the elimination of all unbonded polymer wraps or tubes. Once the pipeline or vessel is set in the trench, conduct an inspection of the coating. This inspection must include electrical holiday detection. Repair any damaged areas of the coating. The Contracting Officer or the Contracting Officer's Representative, Technical Expert or Project Manager must be asked to witness inspection of the coating and testing using a holiday detector.

2.1.2.14.5 Inspection of Pipe Coatings

Any damage to the protective coating during transit and handling must be repaired before installation. After field coating has been applied, inspect the entire pipe using an electric holiday detector in accordance with NACE SP0188 using a full-ring, spring-type coil electrode. The holiday detector must be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Upon detection, immediately repair all holidays in the protective coating. Occasional checks of holiday detector, operation will be made by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager to determine suitability of the detector. Provide all labor, materials, and equipment necessary for conducting the inspection.

2.1.2.14.6 Protective Coating for Aboveground Piping System

Provide finish painting conforming to the applicable paragraph of Section 09 90 00 PAINTS AND COATINGS and as follows:

2.1.2.14.7 Ferrous Surfaces

Touch-up shop-primed surfaces with ferrous metal primer. Solvent-clean surfaces that have not been shop-primed. Surfaces that contain loose rust, loose mill scale, and other foreign substances must be mechanically-cleaned by power wire-brushing and primed with ferrous metal primer. Finish primed surface with two coats of exterior oil paint and vinyl paint.

2.1.3 Performance Requirements

The design must allow for synchronized interruption of all applied current.

2.1.3.1 Criteria of Cathodic Protection

The design must allow for synchronized interruption of all applied current. All galvanic anode leads, or header cables, must be connected to the protected structure through test stations or junction boxes and must never be connected directly to the protected structure.

a. Determination of the on and polarized (instant off) potentials must be made with the protective current applied to the structure for a minimum of 1 . Polarized potentials may be determined using a coupon test station (Error-Free (IR Free) test station). Polarized potentials must be determined by interrupting all the current being applied to the structure or coupon.

b. The potential measurements for the native measurement and the polarized potential must be made with the reference electrode at the same exact location. The polarization decay measurements must also be made with the reference electrode at the same exact location as the polarization potential.

c. The polarization decay measurements will be the difference between the polarized potential and a voltage measurement made 24 hours after the interruption of protective current.

2.1.3.1.1 Steel

A negative polarized potential of 0.85 volts (850 millivolts) or more negative. The voltage must not be more negative than a negative polarized potential of 1.200 volts (1200 millivolts).

2.1.3.1.2 Aluminum

Aluminum underground component must not be protected to a potential more negative than minus 1200 millivolts, measured between the underground component and a saturated copper/copper sulfate reference electrode contacting the earth, directly over the metallic component. Resistance, if required, must be inserted in the anode circuit within the test station to reduce the potential of the aluminum to a value which will not exceed a potential more negative than minus 1200 millivolts. Voltage shift criterion must be a minimum negative polarization shift of 100 millivolts measured between the metallic component and a saturated copper/copper sulfate reference electrode contacting the earth, directly over the metallic component. The polarization voltage shift must be determined as outlined for iron and steel.

2.1.3.1.3 Copper Piping

For copper piping, the following criteria must apply: A minimum of 100 millivolts of cathodic polarization between the structure surface and a stable reference electrode contacting the electrolyte. The polarization voltage shift must be determined as outlined for iron and steel.

2.2 EQUIPMENT

2.2.1 Remote Monitoring

Remote monitoring equipment must be designed, manufactured and procured specifically for cathodic protection use and must be provided as per design and drawings to monitor potential (requires permanent reference electrode) and must match or be compatible with previously installed remote monitoring equipment in use at the installation.

2.2.2 Corrosion Rate Monitoring

Corrosion probes must be designed, manufactured and procured specifically for the application and matched to the structure being protected. Manufacturer must match or be compatible with previously installed rate monitoring equipment in use at the installation.

2.2.3 Polarization Cell Replacement (PCR) and (PCRH) for Hazardous Locations

PCRs and PCRHs must be designed, manufactured, and procured specifically for the application and must exceed the modeled AC steady-state current and fault conditions. For Hazardous locations, the PCRH model must be used.

Characteristic	**PCR**	**PCRH**
AC steady-state current, rms	45A, 80A	45A
AC fault current, rms. at 0.5s	3.7 kA to 15 kA	3.7 kA to 15 kA
Lightning current, 8x20 micros, peak	100 kA	100 kA
Hazardous location certification	Division 2, Zone 2	Division 1, Zone 1
Rain Proof, IP66	Yes	Yes
Submersible, IP68 or NEMA 6P	Optional	No

PCRs must be installed with a protective ground-based enclosure to secure the cable connections and prevent electrical hazards. The PCRH must be installed with an explosion-proof enclosure and must be wall mounted. Structure and Grounding conductors must be properly sized for the application.

AC Fault Current Rating	**Minimum Wire Size (AWG)**	**Minimum Wire Size (Metric)**
1.2 kA, 2kA, 3.7 kA	#6	$16mm^2$

AC Fault Current Rating	Minimum Wire Size (AWG)	Minimum Wire Size (Metric)
5kA 9kA 10kA	#2	$35mm^2$
14kA 15kA	#2/0	$70mm^2$

2.2.4 Solid State Decoupler (SSD)

SSDs must be designed, manufactured, and procured specifically for the application and must exceed the modeled AC steady-state current and fault conditions. For Hazardous locations, the PCRH model must be used. SSDs must be installed with a protective ground-based enclosure to secure the cable connections and prevent electrical hazards.

Characteristic	SSD
AC steady-state current, rms	45A
AC fault current, rms. at 0.5s	1.2 to 5 kA
Lightning current, 8x20micros, peak	75-100 kA
Hazardous location certification	Division 2, Zone 2
Rain Proof, IP66	Yes
Submersible, IP68 or NEMA 6P	Yes

2.3 COMPONENTS

2.3.1 Test Stations

2.3.1.1 Flush Mounted

NEMA ICS 6. Metallic or non-metallic with terminal board, 8 terminal posts and lockable lid. A non-metallic enclosure must be molded of glass filled polycarbonate and urethane coated or Acrylonitrile Butadiene Styrene (ABS) plastic and mounted on a 18 inch length of PVC conduit. The unit must be of standard design, manufactured for use as a CP test station, complete with cover, terminal board, shunts, and brass or Type 304 stainless steel hardware. The terminal board must be removable for easy access to wires. Provide traffic valve box capable of withstanding H-20 traffic loads. The cover must have a cast in legend "CP TEST."

2.3.1.2 Post Top Mounted

NEMA ICS 6. Metallic or non-metallic with terminal board, 8 terminal posts and lockable lid. A non-metallic enclosure must be high impact strength molded plastic. The unit must be of standard design, manufactured for use as a CP test station, complete with cover, terminal board, shunts, and brass or Type 304 stainless steel hardware. The terminal board must be removable for easy access to wires. The test station must be mounted atop 6 foot long polyethylene conduit with anchor. Terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, and reference electrodes).

2.3.1.3 Wall Mounted

NEMA ICS 6, Type 3R enclosure with Type 304 stainless steel hinges and latched cover . Enclosure will be of painted steel construction with terminal board and labeled with nameplate. Provide nameplate in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Enclosure mounting posts must be galvanized steel pipe, schedule 40 , wood post, full length pressure treated with pentachlorophenol . Mount enclosure 42 inches above finished grade . Terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, and reference electrodes).

2.3.1.4 IR-Free Test Station

Must be wall mounted test station to include coupon of the same material as the structure, shunt, permanent reference electrode with means of momentary isolation of the coupon with provided circuitry designed, manufactured and procured exclusively for CP instant off testing of a cathodically protected structure. Must be waterproof if used in flush test stations.

2.3.2 Shunts for Test Stations and Junction Boxes

0.1 ohm, 2 ampere, accuracy plus or minus one percent, polycarbonate circuit board type, color coded for value recognition red for 0.1 ohm shunt with nickel-plated brass posts and standard 0.25 inch inch holes on cm 1 inch centers to fit test stations and terminal boards 0.01 ohm 6 ampere, accuracy plus or minus one percent, manganin wire type.

2.3.3 Junction Box Enclosures

NEMA ICS 6, Type 3R enclosure with Type 304 stainless steel hinges and latched cover . Enclosure must be of painted steel construction with terminal board. Knockout for conduit must be the size and location as per design drawings.

2.3.3.1 Nameplates

Provide nameplate in accordance with Section26 20 00 INTERIOR DISTRIBUTION SYSTEM and ASTM D709. Provide laminated plastic nameplates for each enclosure as specified or as indicated on the drawings. Each nameplate inscription must identify the function. Nameplates will be melamine plastic, 0.125 inch thick, white with black center core. Surface will be matte finish. Corners will be square. Accurately align lettering and

engrave into the core. Minimum size of nameplates must be 25 inch by 2.5 inches. Lettering must be a minimum of 0.25 inch high normal block style.

2.3.4 Terminal Boards

Provide terminal boards for anode junction boxes, bonding boxes, and test stations made of phenolic plastic 1/4 inch thick with dimensions as indicated. Insulated terminal boards must have the required number of terminals (one terminal required for each conductor). Install solderless copper lugs and copper buss bars, shunts, and variable resistors on the terminal board as indicated. Test station terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, reference electrodes and coupons).

2.3.5 Anode Junction Boxes

2.3.5.1 Enclosure

NEMA ICS 6, Type 3R enclosure with Type 304 stainless steel hinges and latched cover. Enclosure must be of painted steel construction with terminal board and labeled with nameplate. Provide nameplate in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.3.5.2 Terminal Boards

Provide terminal boards for anode junction boxes, bonding boxes, and test stations made of phenolic plastic 1/4 inch thick with dimensions as indicated. Insulated terminal boards must have the required number of terminals (one terminal required for each conductor). Install solderless copper lugs and copper buss bars, shunts, and variable resistors on the terminal board as indicated. Test station terminal connections will be permanently tagged to identify each termination of conductors (e.g. identify the conductors connected to the protected structure, anodes, and reference electrodes).

2.4 MATERIALS

2.4.1 Galvanic Anodes

2.4.1.1 Dimensions and Weights

Bare anode weight 9 pounds not including core.

2.4.1.2 Standard Magnesium Anodes

Install a minimum of 2 anodes on the Pipe system. See Paragraph METALLIC COMPONENTS ON NON-METALLIC SYSTEMS AND TYPICALS for additional anodes under slab.

2.4.1.2.1 Anode Composition

Anodes must be of high-potential magnesium alloy, made of primary magnesium obtained from sea water or brine, and not made from scrap metal. Magnesium anodes must conform to ASTM B843 and to the following analysis (in percent) otherwise indicated:

Aluminum	0.010 percent
Manganese	0.50 to 1.30 percent max
Zinc	0.05 percent max
Silicon	0.05 percent max
Copper	0.02 percent max
Nickel	0.001 percent max
Iron	0.03 percent max
Other impurities	0.05 each or 0.3 percent max total
Magnesium	Remainder

Furnish spectrographic analysis on samples from each heat or batch of anodes used on this project.

2.4.1.2.2 Dimensions and Weights

The following dimensions and weights of anodes are not all inclusive and are presented as examples, various manufacturers may have additional sizes not included in the following table:

a. Bare anode weight: 9 pounds .

Typical Magnesium Anode Size (may be round, square, or D shaped)												
Nominal Weight Bare		**Approximate Size**						**Packaged Weight**		**Nominal Packaged Dimensions**		
kg	**lbs**	**Width**		**Height**		**Length**		**kg**	**lbs**	**Diameter**		**Length**
		mm	**inch**	**mm**	**inch**	**mm**	**inch**			**mm**	**inch**	**mm**	**inch**
	1		1.75		1.75		8		5		3.25		9
	3		3.5		3.75		5		8		6		10
	5		3.5		3.75		8.5		17		6		12
	9		2.75		3		27	15.9	35		5.5		32
	9		3.5		3.75		14		27		6		17
	17		2.75		2.75		50.25		60		6		55
	17		3.5		4		25.75		45		6.5		29
	20		2.75		3.75		59.75		70		5		66
	32		3.5		3,75		45.25		91		6.5		53
	32		5.5		5		20.5		70		8		28
	40		3.5		3.75		59.75		96		6.5		66

Typical Magnesium Anode Size (may be round, square, or D shaped)													
Nominal Weight Bare		Approximate Size						Packaged Weight		Nominal Packaged Dimensions			
	48		5.5		5.75		31		100		8		38
	60		4		4		60		125		7		64

2.4.1.2.3 Packaged Anodes

Provide anodes in packaged form with the anode surrounded by specially-prepared quick-wetting backfill and contained in a water permeable cloth or paper sack. Anodes must be centered by means of spacers in the backfill material.

The backfill material will have the following composition, unless otherwise indicated:

Material	Approximate Percent by Weight
Gypsum	75
Bentonite	20
Sodium Sulfate	5
Total	100

2.4.1.3 Cast Zinc Anodes

ASTM B418, Type II. Bare anode weight: 5 pounds not including core.

Typical Zinc Bare Anode Sizes and Packaged Weight									
Bare Weight		Width		Height		Length		Total Packaged Weight	
kg	pounds	mm	inches	mm	inches	mm	inches	kg	pounds
	5		1.4		1.4		10		20
	12		1.4		1.4		24		40
	15		1.4		1.4		30		50
	15		2.0		2.0		15		36
	18		1.4		1.4		36		55
	30		1.4		1.4		60		86
	30		2.0		2.0		30		67
	45		2.0		2.0		45		100

Typical Zinc Bare Anode Sizes and Packaged Weight									
Bare Weight		Width		Height		Length		Total Packaged Weight	
kg	pounds	mm	inches	mm	inches	mm	inches	kg	pounds
	60		2.0		2.0		60		120

2.4.1.3.1 Anode Composition

Chemical composition as follows:

Zinc	4.5 percent maximum
Indium	0.02 percent maximum
Silicon	0.01 percent maximum
Aluminum	Remainder

2.4.1.4 Aluminum Anodes

2.4.1.4.1 Anode Composition

Chemical composition as follows:

Zinc	4.5 percent maximum
Indium	0.02 percent maximum
Silicon	0.01 percent maximum
Aluminum	Remainder

2.4.1.4.2 Dimensions and Weights

Anode Weight 10 pounds not including core.

2.4.1.4.3 Anode Core

Iron galvanized steel rod pipe , 1/4 inch diameter 3 by 8.

2.4.2 Wire and Cable

2.4.2.1 Anode Lead Wire

Wire must be No. 12 AWG solid copper wire, not less than 10 feet long, without any splices, complying with NFPA 70, Type Thermoplastic Heat and Water-resistant Nylon-coated (THHN) THHN Rubber Heat (resistant) Wire (RHW) insulation. Connecting wires for zinc anodes must be factory installed with the place of connection to the protruding steel core completely sealed with a dielectric material.

2.4.2.2 Welded Connected Anodes

UL 83, Type THHN , stranded copper conductors, not less than No. 12 AWG, 10 feet long, of sufficient length to extend to the accompanying junction box without splicing. Anode lead wire will be factory installed. Silver solder the lead wire to the anode core, and seal the soldered connection and recessed end of the anode with an epoxy dielectric sealing compound. Dielectric material must extend past the connection and cover the lead wire insulation by not less than 1/2 inch.

2.4.2.3 Anode Header Cable

Cable for anode header and distribution will be No. 10 AWG stranded copper wire with type CP HMWP, 7/64 inch thick insulation, 600-volt rating.

2.4.2.4 Structure (Negative) Cable

Structure connecting wire must be No. 2 AWG stranded copper wire with type THHN insulation, 600 volt rating. Copper conductors conforming to ASTM B3 and ASTM B8.

2.4.2.5 Test Wires

Test wires must be No. 12 AWG stranded copper wire with NFPA 70 Type Thermoplastic Wire (TW) or RHW or polyethylene insulation. Copper conductors conforming to ASTM B3 and ASTM B8.

2.4.2.6 Joint and Continuity Bond Cables

Provide bonds across joints or any electrically discontinuous connections in the piping, and other pipes and structures with other than welded or threaded joints included in this CP system. Unless otherwise specified, bonds between structures and across joints in pipe with other than welded or threaded joints must be with No. 4 AWG stranded copper cable with polyethylene insulation. Bonds between structures must contain sufficient slack for any anticipated movement between structures. Bonds across pipe joints must contain a minimum of 4 inch of slack to allow for pipe movement and soil stress. Bonds must be attached by exothermic welding. Exothermic weld areas must be insulated with coating compound and approved by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Continuity bonds must be installed as necessary to reduce stray current interference. Additional joint bonding must be done where determined during construction or testing or as directed. Joint bonding must include excavation and backfilling. There must be a minimum of 2 continuity bonds between each structure and other than welded or threaded joints. Electrical continuity must be tested across joints with other than welded or threaded joints and across metallic portions of sewage lift stations and water booster stations. Copper conductors conforming to ASTM B3 and ASTM B8.

2.4.2.7 Resistance Bond Wires

Resistance bonds must be adjusted for minimum interference while achieving the criteria of protection. Alternate methods may be used when approved.

2.4.2.8 Polyethylene Insulation

Polyethylene insulation must comply with the requirements of ASTM D1248 and of the following types, classes, and grades:

2.4.3 Cable and wire Identification Tags

Stainless steel material with engraved letters. Print letters and numbers a minimum of 3/16 inch in height. Provide identifier legend in accordance with the drawings .

2.4.4 Anode Connection

2.4.4.1 End-Connected Anode

Drill a recess 6 inches deep in one end of the anode. Attach the lead wire to the anode with an anchor device. Not more than 1/2 inch of bare wire must protrude from the anchor device. Attachment must withstand a 325 pound pull without loosening the wire or anchor device. Fill the recess with an epoxy sealing compound , leaving sufficient space for a plug. Install a heat-shrinkable anode cap over the attachment. Cap must extend not less than 2 1/2 inches on the lead wire and 3 inches on the anode. Cable-to-anode contact resistance must not exceed 0.02 ohms.

2.4.4.2 Center-Connected Anode

Attach the lead wire to the center of the anode with an anchor device suitably fastened to the wire. Not more than one inch of bare wire must protrude from the anchor device. Encapsulate each side of the connection point with a minimum of 6 inches of high voltage insulating compound mastic and 4 inches of epoxy resin. Attachment must withstand 900 pounds pull without loosening the wire or anchor device. Provide a non-metallic plug flush with the anode end to prevent chaffing of the anode lead wire. Cable-to-anode contact resistance must not exceed 0.02 ohms.

2.4.5 AC Mitigation Materials

If required, AC mitigation materials typically consist of a mitigation material either zinc ribbon or copper cable, interconnecting coated copper cables, solid state decouplers to control the AC current flow and test stations.

2.4.6 Backfill Material

The backfill material must have the following composition, unless otherwise indicated:

Material	Approximate Percent by Weight
Gypsum	75
Bentonite	20
Sodium Sulfate	5
Total	100

2.4.7 Permanent Reference Electrodes

Permanent reference electrodes must be copper/copper-sulfate specifically manufactured for underground use, 1 1/4 inch diameter, by 10 inches long, plastic tube with an ion trap to minimize contamination of the electrode .

Must never need recharging, maintenance, or recalibration. Must have impregnated membrane which keeps electrode electrolytes from drying out or getting the reference electrode electrolyte contaminated. Must have ion trap to prevent reference electrode damage from hydrogen sulfide or excess chloride ions. The electrode will be prepackaged by the manufacturer with a backfill material as recommended by the manufacturer. Provide electrodes with No. 12 AWG, THHN cable of sufficient length to extend to the junction box without splicing. Reference electrodes will have a minimum 20-year life, stability of plus or minus 5 millivolts under 3 microamp load. The manufacturer must calibrate the PRE to 316 mV plus or minus 10mV referenced to a standard hydrogen electrode (SHE) and provide a calibration certificate detailing the results of the calibration. Procedures for evaluating the accuracy annually must be included in the Operation and Maintenance Manual.

2.4.8 Pavement Inserts

Pavement insert must be a non-metallic flush type test station without terminal board, and must allow a copper/copper sulfate reference electrode to contact the electrolyte beneath the pavement surface. Provide traffic valve box capable of withstanding H-20 traffic loads.

2.4.9 Coupons

Coupons must match the material of the structure, with 1 integrated connection(s) with electrical wire(s) and be designed, manufactured and procured for use as a corrosion coupon, IR-Free reference electrode, or AC reading electrode.

2.4.10 Zinc Grounding Cells

Two Zinc Type I anodes separated with 1 inch isolating spacers. Minimum 10 feet of #6 AWG HMWPE CP cable crimped securely to each anode. Both anodes centered in one cloth bag and surrounded with low resistance backfill mixture consists of 75 percent hydrated gypsum, 20 percent bentonite, and 5 percent sodium sulfate.

Element	**Content Percent**	
	MIL-A-18001 ASTM B418 Type I	**ASTM B418 Type II**
Al	0.1 - 0.5 percent	0.005 percent max
Cd	0.02 - 0.07 percent	0.003 percent max
Fe	0.005 percent max	0.0014 percent max
Pb	0.006 percent max	0.003 percent max
Cu	0.005 percent max	0.002 percent max
Zinc	Remainder	Remainder

Bare Weight		Width		Height		Length		Total Packaged Weight	
kg	pounds	mm	inches	mm	inches	mm	inches	kg	pounds
	5		1.4		1.4		10		20
	12		1.4		1.4		24		40
	15		1.4		1.4		30		50
	15		2.0		2.0		15		36
	18		1.4		1.4		36		55
	30		1.4		1.4		60		86
	30		2.0		2.0		30		67
	45		2.0		2.0		45		100
	60		2.0		2.0		60		120

2.4.11 Isolation Flange Kits

Provide full-faced gaskets, isolating sleeves and washers, and steel washers. Provide isolation flange kits rated for operation at the rated pressure and temperature.

2.4.11.1 Gaskets

ASME B16.21. Laminated phenolic material for operation at 450 degrees F.

2.4.11.2 Isolating Washers and Sleeves

Two sets 1/8 inch laminated phenolic for operation at 450 degrees F. Isolating washers must fit within the bolt facing on the flange over the outside of the fabric reinforced phenolic sleeve.

2.4.11.3 Washers

Steel, cadmium plated, to fit within the bolt facing on the flange.

2.4.12 Steel Flanges and Bolting

2.4.12.1 Steel Flanges

ASME B16.5, 150 lb. .

2.4.12.2 Bolting

ASTM A307, Grade B for bolts; ASTM A194/A194M, Grade 2 for nuts. Dimensions: ASME B18.2.1 for bolts, ASME B18.2.2 for nuts. Threads: ASME B1.1, Class 2A fit for bolts, Class 2B fit for nuts. Bolts must extend completely through the nuts and may have reduced shanks of a

diameter not less than the diameter at the roof of threads.

2.4.13 Dielectric Unions

ASME B16.39, Class 1 for dimensional, strength, and pressure requirements. Insulation barrier must limit galvanic current to one percent of the short-circuit current in a corresponding metallic joint. Provide insulating material impervious to water .

2.4.14 Isolation and End Seals

2.4.14.1 Casing Isolator/Centralizer

Polycarbonate Hi-Temp isolators/spacers rated for service at least 280 degrees F positive electrical isolation, high abrasion resistance and low coefficient of friction.

2.4.14.2 End Seals

Ethylene Propylene Diene Monomer (EPDM) Neoprene rubber end seals, thickness of 1/8 inch or more, with 2 Stainless Steel Pipe Clamps per end seal, 1/8 inch thick and 1/2 inch wide or more.

2.5 ACCESSORIES

2.5.1 Conduit

UL 6, rigid galvanized steel, Outlet boxes: UL 514A and fittings UL 514B, threaded hubs. Metallic conduit and fittings to be PVC coated in accordance with NEMA RN 1, Type A40, NEMA TC 2, Type EPC-40-PVC. Non-metallic conduit must conform to NEMA TC 2.

2.5.2 Joint, Patch, Seal, and Repair Coating

Sealing and dielectric compound must be a black, rubber based compound that is soft, permanently pliable, tacky, moldable, and unbacked. Compound will be applied as recommended by the manufacturer, but not less than 1/2-inch thick. Coating compound must be cold-applied coal-tar base mastic . Pressure-sensitive vinyl plastic electrical tape and rubber insulated tape must conform to UL 510.

2.5.3 Underground Splices

Provide splices with a compression connector on the conductors, and insulation and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply with ANSI C119.1.

2.5.3.1 Cast-Type Splice

Provide cast-type splice insulation by means of molded casting process employing a thermosetting epoxy resin insulating material applied by a gravity poured method or pressure injected method. Provide component materials of the resin insulation in a packaged form ready for convenient mixing without removing from the package.

2.5.3.2 Gravity-Poured Splice

Gravity-poured method must employ materials and equipment contained in and approved commercial splicing kit which includes a mold suitable for the

cables to be spliced. When the mold is in place around the joined conductors, prepare the resin mix and pour into the mold.

2.5.3.3 Heat Shrinkable Splice

Provide heavy wall heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material which must be applied by a clean burning propane gas torch.

2.5.4 Electrical Isolation of Structures

2.5.4.1 Electrically Isolating Pipe Joints

Electrically isolating pipe joints will be of a type that is in regular factory production.

2.5.4.2 Electrically Isolating Couplings

Electrically isolating couplings will be of a type that has a published maximum electrical resistance rating given in the manufacturer's literature. Cradles and seals will be of a type that is in regular factory production made for the purpose of electrically isolating the carrier pipe from the casing and preventing the incursion of water into the annular space.

2.5.5 Electrical Insulating Coating

Conformable watertight sealant having dielectric strength not less than 15 kV for a 1/8 inch thick layer.

2.5.6 Buried Cable Warning and Identification Tape

Polyethylene tape, manufactured for warning and identification of buried cable and conduit. Tape must be 3 inches wide, Yellow in color and read "Caution Buried Cable Below" or similar. Color and lettering must be permanent and unaffected by moisture or other substances in backfill materials.

2.5.7 Electrical Connection to Structures

2.5.7.1 Exothermic Welds

Electrical connections to metallic structures must be made using exothermic welds in strict accordance with the manufacturer's recommendations.

2.5.7.2 Electrical-Shielded Arc Welds

Electrical-shielded arc welds must be approved for use on steel pipe by shop drawing submittal action.

2.5.7.3 Brazing

Brazing will be as specified by manufacturer using specialized equipment designed for that purpose.

2.5.8 Electrical Tape

Pressure-sensitive vinyl plastic electrical tape and rubber insulated tape

must conform to UL 510.

2.5.9 Exothermic Weld Kits

Exothermic weld kits specifically designed by the manufacturer for exothermic welding wires to metallic surfaces. Molds must be for specific type of metallic structure (steel, cast iron), specific diameter of pipe or metallic surface and specific size (AWG)and type of wire (solid, stranded).

2.6 TESTS, INSPECTIONS, AND VERIFICATIONS

2.6.1 Non-Destructive Testing of Anodes

Contractor must perform the tests in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. One anode of each type will be chosen at random for non-destructive testing and will be submerged in a container of fresh water for about 30 minutes. Contractor must then measure the anode-to-water potential difference between a calibrated copper/copper sulfate reference electrode. Potential differences must generally be within the following ranges:

Anode Type	**DC Volts to Calibrated Cu/CuSO4 Reference Electrode**
High Potential Magnesium	More Negative than Negative 1.65 Volts DC
Standard Magnesium	More Negative than Negative 1.4 Volts DC
Zinc	More Negative than Negative 1.0 Volts DC
Aluminum	More Negative than Negativee 1.0 Volts DC

Failure of the test anode to conform to this specification can be cause for rejecting all anodes from the same lot as the test anode. The contractor must mark all rejected anodes on the ends with a 6 inch high "X" using yellow spray paint. Failed anodes must be removed from the job site by the end of the day. The contractor must replace any rejected anodes at the contractor's expense. The destructive testing provision must also apply to replacement anodes as well.

2.6.2 Destructive Testing of Anodes

Contractor must perform the tests in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Contractor must include the cost of an additional anode of each different type with the longest lead wire for the destructive test in the contractor's bid. One completed prepackaged anode of each type with lead wires will be chosen at random for destructive testing and must be submitted to a static pull test. Anode wire connections must have sufficient strength to withstand a minimum tensile load of 300 pounds. Failure of the test anode to conform to this specification can be cause for rejecting all anodes from the same lot as the test anode. The contractor must mark all rejected anodes on the ends with a 6 inch high "X" using yellow spray paint. Failed anodes must be removed from the job site by the end of the day. The contractor must replace any rejected anodes at the contractor's expense. The destructive testing provision

will also apply to replacement anodes as well.

PART 3 EXECUTION

3.1 SAFETY PRECAUTIONS AND HAZARDOUS LOCATIONS

Any personnel performing operations that will generate heat, sparks, or flame in hazardous locations must first perform adequate safety precautions. A trained responsible person must ensure the area is safe to perform the operation. Required actions include ensuring adequate ventilation before work starts, air monitoring, and a fire watch must be provided and remain for 30 minutes after the operation is completed. A minimum of 20 pound ABC type fire extinguisher must be available and must be inspected before each use. Equipment being used must be inspected and used in accordance with manufacturer recommendations. Combustibles that are in the work area(s) must be moved or if they cannot be moved, be covered with fire retardant welding blankets. When performing exothermic welding, properly sized charges and inspection of the structure condition must be accomplished to ensure a safe operation.

3.2 INSTALLATION

3.2.1 Excavation and Trenching

Perform trenching and backfilling in accordance with Section 31 00 00 EARTHWORK . In the areas of the anode beds, all trees and underbrush will be cleared and grubbed to the limits shown or indicated. In the event rock is encountered in providing the required depth for anodes, determine an alternate approved location and, if the depth is still not provided, submit an alternate plan to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Alternate techniques and depths must be approved prior to implementation.

3.2.2 Anode Excavation

a. Excavate hole to a minimum 3 inches larger than the packaged anode diameter, feet deep.

3.2.3 Lead Wire Trench

b. Excavate lead wire trench to 24 inches deep, 12 inches wide.

3.3 ANODES AND LEAD WIRE

3.3.1 Anode Installation

Unless otherwise authorized, installation must not proceed without the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Anodes of the size specified must be installed to the depth indicated and at the locations shown. Locations may be changed to clear obstructions with the approval of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Anodes will be installed in sufficient number and of the required type, size, and spacing to obtain a uniform current distribution over the surface of the structure. The anode system will be designed for a life of 25 years of continuous operation. Anodes must be installed as indicated in a dry condition after any plastic or waterproof protective covering has been completely removed from the water permeable, permanent container housing the anode metal. The anode

connecting wire must not be used for lowering the anode into the hole. The annular space around the anode must be backfilled with fine earth in 6 inch layers and each layer must be hand tamped.

3.3.1.1 Single Anodes

Single anodes, spaced as shown, will be connected to the pipeline, allowing adequate slack in the connecting wire to compensate for movement during backfill operation.

3.3.1.2 Group of Anodes

Groups of anodes, in quantity and location shown, must be connected to an anode header cable. The anode header cable must make contact with the structure to be protected only through a test station. Anode lead connection to the anode header cable must be made by an approved crimp connector or exothermic weld and splice mold kit with appropriate potting compound.

3.4 INSTALLATION DETAILS

3.4.1 Anode Installation

Do not lift or support anode by the lead wire. Where applicable, remove manufacturer's plastic wrap/bag from the anode. Exercise care to preclude damaging the cloth bag and the lead wire insulation. Center the packaged anode in the hole with native soil in layers not exceeding 6 inches. Hand tamp each layer to remove voids taking care not to strike the anode lead wire. When the backfill is 6 inches above the top of the anode, pour at least ten gallons of water into the hole to saturate the anode backfill and surrounding soil. Anodes must not be backfilled prior to inspection and approval by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

3.4.2 Lead Wire Installation

Cover the lead wire trench bottom with a 3 inch layer of sand or stone free earth. Center wire on the backfill layer. Do not stretch or kink the conductor. Place backfill over wire in layers not exceedingsix inches deep. Compact each layer thoroughly. Do not place tree roots, wood scrap, vegetable matter and refuse in backfill. Place cable warning tape within 18 inches of finished grade, above cable and conduit.

3.4.2.1 Lead Wire Connections

Connect anode lead wire(s) directly to the protected structure(s) by use of exothermic weld kit(s). Clean the structure surface by scraping, filing or wire brushing to produce a clean, bright surface. Weld connections using exothermic welding kit(s) in accordance with the kit manufacturer's instructions. Check and verify adherence of the bond to the substrate for mechanical integrity by striking the weld with a 2 pound hammer. Cover connections with an electrically insulating coating which is compatible with the existing coating on the structure. The coating must be completely cured before backfilling. Allow sufficient slack in the lead wire to compensate for movement during backfilling operation.

3.4.2.2 Field Drawing

Complete a field drawing of each anode installation showing location of

anode, test station, depth of anode, color and size of anode lead wire and any other pertinent details. Submit copy with daily report to the government.

3.4.2.3 Metallic Underground Pipeline Connection

To facilitate periodic electrical measurements during the life of the sacrificial anode system and to reduce the output current of the anodes, if required, all anode lead wires must be connected to a test station and buried a minimum of 24 inches in depth. The cable must be No. 10 AWG, stranded copper, polyethylene or RHW-USE insulated cable. The cable must make contact with the structure only through a test station. Resistance wire must be installed between the cable and the pipe cable, in the test station, to reduce the current output, if required. Anode connections, except in the test station, must be accomplished by exothermic welding, and must be insulated by means of at least three (3) layers of electrical tape; and all lead wire connections must be installed in a moisture-proof splice mold kit and filled with epoxy resin. Lead wire-to-structure connections must be accomplished by an exothermic welding process. All welds must be in accordance with the manufacturer's recommendations. A backfill shield filled with a pipeline mastic sealant and material compatible with the coating must be placed over the weld connection and be of such diameter as to cover the exposed metal adequately. Anodes must be installed at a minimum of 8 feet and a maximum of 10 feet from the structure to be protected.

Contractor must take proper safety precautions prior to and during welding to live pipelines tanks. Contractor must notify the activity Fuel Office via the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager a minimum of three days before performing exothermic welding to live lines. Exothermic welding must be conducted with product flowing through the pipeline to eliminate vapor spaces within the pipe and to dissipate the heat on the pipe. Exothermic weld charges for connections to live lines must be limited to a maximum 15 gram charge to prevent burning through the pipe wall. Exothermic weld connections must be spaced a minimum of6 inches apart. In the event of an unsuccessful weld, the new weld location must be located a minimum of 6 inches from the unsuccessful weld and any other existing welds. Contractor must obtain the services of a certified safety professional to monitor the construction site during exothermic welding work and certify that the area is free of flammable vapors and otherwise safe for work.

3.4.3 Underground Pipe Joint Bonds

Underground pipe having other than welded or threaded coupling joints must be made electrically continuous by means of a bonding connection installed across the joint.

3.4.4 Anode Junction Boxes

Provide junction boxes and mark each of the wires terminating in each box.

3.4.5 Bonding Boxes

Provide structure bonding boxes in locations where the protected structure crosses or comes into close proximity to other metal structures that are unprotected or protected by its own electrically isolated CP system(s).

3.4.6 Test Stations and Permanent Reference Electrodes

Test stations will be of the type and location shown and will be curb box mounted. Provide buried isolation joints with test wire connections brought to a test station. Reference all test stations with GPS coordinates. Unless otherwise shown, locate other test stations and permanent reference electrodes as follows:

a. At 1000 foot intervals.

b. At all isolation joints.

c. At both ends of casings.

d. Where the pipe crosses any other metal pipes.

e. Where the pipe connects to an existing piping system.

f. Where the pipe connects to a dissimilar-metal pipe.

Do not fill the bottom of the test station with concrete unless otherwise specified. Do not place rubbish, scrap or other debris into the test station.

3.4.7 Permanent Reference Electrode Verification

Verify permanent reference electrodes against a calibrated portable electrode in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager before installation. Verify in a non-metallic container of water. Permanent electrode must measure a reference potential agreeing with that measured by the portable electrode within plus or minus 0.010 volts when the sensing windows of the two electrodes being compared are not more than 1/6 inch apart but not touching. Remove permanent reference electrodes not within this potential range from the construction site by the end of the day and replace at the contractor's expense. The testing provision applies to replacement permanent reference electrodes as well.

3.4.7.1 Field Drawings

Complete a field drawing of each anode installation showing location of anode, depth of anode, color and size of anode lead wire and any other pertinent details . Submit copy with daily report to the government.

3.5 ELECTRICAL ISOLATION OF STRUCTURES

3.5.1 Isolation Fittings

Isolating fittings, including isolating flange kits, dielectric unions and couplings, must be installed aboveground, or within manholes, wherever possible. Where isolating joints must be covered with soil, they must be fitted with a proper joint cover specifically manufactured for covering the particular joint, and the space within the cover filled with hot coal-tar enamel or hot petrolatum wax. Isolating fittings in lines entering buildings must be located at least 12 inch above grade of floor level, when possible. Isolating joints must be provided with grounding cells to protect against over-voltage surges or approved surge protection devices. The cells must provide a low resistance across isolating joint without excessive loss of cathodic current.

3.5.2 Dielectric Unions

Cut pipe ends square, remove fins and burrs, cut taper pipe threads in accordance with ASME B1.20.1. Provide isolation unions as indicated. Work piping into place without springing or forcing. Apply joint compound or thread tape to male threads only. Backing off to permit alignment of threaded joints will not be permitted. Engage threads so that not more than three threads remain exposed.

3.5.3 Gas Distribution Piping

Electrical isolation will be provided at each building riser pipe to the pressure regulator, at all points where a short to another structure or to a foreign structure may occur, and at other locations as indicated on the drawings. If an isolating joint is located inside a vault, the pipe must be sleeved when entering and leaving the vault. A non-metallic sleeve is to be used.

3.5.4 Joint Bonds

Provide joint bonds on metallic pipe to and across buried flexible couplings, mechanical joints, flanged joints except at places where isolation joints are specified and joints not welded or threaded to provide electrical continuity. Connect bond wire(s) to the structure(s) by use of exothermic weld kit(s). Clean the structure surface by scraping, filing or wire brushing to produce a clean, bright surface. Weld connections using exothermic kits in accordance with the kit manufacturer's instructions. Check and verify adherence of the bond to the substrate for mechanical integrity by striking the weld with a 2 pound hammer. Cover connections with an electrically insulating coating which is compatible with the existing coating on the structure.

3.5.5 Casings, Isolation, and Seals

Where the pipeline is installed in a casing under a roadway or railway, isolate the pipeline from the casing, and seal the annular space against intrusion of water.

3.6 FIELD QUALITY CONTROL

Field tests must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager or their designated representative. Advise the Contracting Officer or Contracting Officer's Representative 5 days prior to performing each field test. Quality control for the cathodic protection system must consist of the following:

a. Initial field testing by the contractor upon construction.

b. Government Field Testing after contractor initial field test report submission.

c. Warranty period field testing by the contractor.

d. Final field testing by the contractor after one year of service.

3.6.1 Tests and Measurements

3.6.1.1 Native Potentials

Notify the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager a minimum of five (5) working days prior to each test. Base potential tests: At least 24 hours after installation of structure to be protected and installation of the anodes, but before connection of anodes to the structure, measure base (native) structure-to-electrolyte potentials of the structure. Perform measurements at anode junction boxes, test stations and other locations suitable for test purposes (such as service risers or valves), at intervals not exceeding 100 feet with readings at each end point and the midpoints as a minimum. The locations of these measurements must be identical to the locations specified for potential measurements with anodes connected. Use the same measuring equipment that is specified for measuring protected potential measurements.

3.6.1.2 Protected Potentials

Systems must be tested and inspected by the contractor's corrosion engineer in the presence of the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager corrosion protection engineer or an approved representative. Notify the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager a minimum of five working days prior to each test. At least 24 hours after native potential testing and connection of anodes to the structure, measure protected structure-to-electrolyte potentials. The locations of these measurements must be identical to the locations specified for native potential measurements. For underground storage tanks, take a minimum of three measurements with the reference electrode located as follows: Directly over the longitudinal and transverse centerlines of the tank at intervals not exceeding the diameter of the tank and to a distance from the tank of two times the tank diameter. Use the same measuring equipment that is specified for measuring protected potential measurements. Record test data, including date, time, and locations of testing and submit report to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Contractor must correct and retest, at the contractor's and Technical Expert's expense, deficiencies in the materials and installation observed by these tests and inspections.

3.6.1.3 Isolation Testing

Before the anode system is connected to the pipe , an isolation test must be made at each isolating joint or fitting. This test will demonstrate that no metallic contact, or short circuit exists between the two isolated sections of the pipe . Any isolating fittings installed and found to be defective must be reported to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager.

3.6.1.4 Isolation Tester

An Isolation Tester designed and manufactured for use in CP, using the continuity check circuit, must be used for all isolating joint (flange) electrical testing. Testing must conform to the manufacturer's operating instructions. Test must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. An isolating joint that is good will read full scale on the

meter. If an isolating joint is shorted, the meter pointer will be deflected or near zero on the meter scale. Location of the fault will be determined from the instructions, and the joint must be repaired.

3.6.1.5 Anode Output

As the anodes or groups of anodes are connected to the pipe , current output will be measured with an approved clamp-on milliammeter, calibrated shunt with a suitable millivoltmeter or multimeter, or a low resistance ammeter. (Of the three methods, the low-resistance ammeter is the least desirable and most inaccurate. The clamp-on milliammeter is the most accurate.) The values obtained and the date, time, and location must be recorded.

3.6.1.6 Reference Electrode Potential Measurements

Upon completion of the installation and with the entire CP system in operation, electrode potential measurements must be made using a copper/copper sulfate reference electrode and a potentiometer-voltmeter, or a direct-current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements must be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements must be recorded. No less than eight (8) measurements will be made over any length of line or component. Additional measurements will be made at each distribution service riser, with the reference electrode placed directly over the service line.

3.6.1.7 Casing Tests

Before final acceptance of the installation, the electrical isolation of carrier pipe from casings must be tested and any short circuits corrected.

3.6.1.8 Holiday Test

Any damage to the protective coating during transit and handling must be repaired before installation. After field-coating has been applied, the entire pipe must be inspected by an electric holiday detector with impressed current in accordance with NACE SP0188 using a full-ring, spring-type coil electrode. The holiday detector will be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective coating must be repaired upon detection. Occasional checks of holiday detector potential will be made by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager to determine suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection must be furnished by the contractor. The coating system must be inspected for holes, voids, cracks, and other damage during installation.

3.6.1.9 Stray Current Measurements

Before final acceptance of the installation, stray current tests must be performed on any foreign pipes, tanks, or other metallic structures in close proximity to the installed anodes. A full report of the tests giving all details must be made.

3.6.1.10 Induced AC Testing

Before final acceptance of the installation, induced AC Voltage tests must be performed on the pipes near high AC Voltage infrastructure and where crossing above ground and underground AC transmission systems. A full report of these tests must be included in the final testing reports with all details and data taken. The touch potential of any testing over 5 volts must be reported to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Any touch potential over 10 Volts must be mitigated by effective mitigation techniques. Refer to NACE SP0177 and NACE SP21424.

3.6.1.11 Interference Tests

Before final acceptance of the installation, interference tests will be made with respect to any foreign pipes in cooperation with the owner of the foreign pipes . A full report of the tests giving all details must be made. Stray current measurements must be performed at all isolating locations and at locations where the new pipeline crosses foreign metallic pipes; results of stray current measurements must also be submitted for approval. The method of measurements and locations of measurements must be submitted for approval. As a minimum, stray current measurements must be performed at the following locations:

a. Connection points of new pipeline to existing pipeline.

b. Crossing points of new pipeline with other existing metallic pipelines.

3.6.1.12 Initial Cathodic Protection System Field Testing

Initial field testing must be completed by the contractor upon completion of construction. Field testing must be witnessed by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager or their designated representative. Advise the Contracting Officer or Contracting Officer's Representative 5 days prior to performing each field test. Field testing must include native and protected potentials, and anode current testing.

The contractor must submit an initial field test report of the cathodic protection system. All structure-to-electrolyte measurements, including initial potentials, anode outputs, and other required testing must be recorded on applicable forms. Identification of test locations, test station and anode test stations will coordinate with the as-built drawings and be provided on system drawings included in the report. The contractor must locate, correct, and report to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager any short circuits encountered during the checkout of the installed CP system.

3.6.1.13 Government Field Testing

The government corrosion engineer must review the contractor's initial field testing report. Approximately four weeks after receipt of the contractor's initial test report, the system will be tested and inspected in the contractor's presence by the government corrosion engineer . The contractor must correct, at the contractor's expense, materials and installations observed by these tests and inspections to not be in conformance with the plans and specifications. The contractor will pay for all retesting done by the government engineer made necessary by the

correction of deficiencies.

3.6.1.14 One-Year-Warranty-Period-Testing

The contractor must inspect, test, and adjust the cathodic protection system semi-annually for one year, 4 interim inspections total, to ensure its continued conformance with the criteria outlined below. The performance period for these tests will commence upon the completion of all cathodic protection work, including changes required to correct deficiencies identified during initial testing, and preliminary acceptance of the cathodic protection system by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Copies of the One Year Warranty Period Cathodic Protection System Field Test Report, including field data, and certified by the contractor's corrosion engineer must be submitted to the Contracting Officer or Contracting Officer's Representative, the activity, and the geographic EFD corrosion engineer .

3.6.1.15 Final Acceptance Field Testing

Conduct final field testing of the cathodic protection system utilizing the same procedures specified under, "Initial Field Testing of the Galvanic Cathodic Protection Systems". The contractor will inspect, test, and adjust the cathodic protection system after one year of operation to ensure its continued conformance with the criteria outlined below. The performance period for these tests will commence upon preliminary acceptance for the cathodic protection system by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager. Copies of the Final Cathodic Protection System Field Test Report, certified by the contractor's corrosion engineer must be submitted to the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager and the geographic EFD corrosion engineer for approval, and as an attachment to the operation and maintenance manual in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. The government corrosion engineer must review the contractor's final field testing report.

3.7 CLOSEOUT ACTIVITIES

3.7.1 Reconditioning of Surfaces

3.7.1.1 Concrete

Concrete must be 3000 psi minimum ultimate 28-day compressive strength with one inch minimum aggregate conforming to ASTM C94/C94M.

3.7.1.2 Restoration of Sod

Restore unpaved surfaces disturbed during the installation of anodes and wires to their original elevation and condition. In areas where grass cover exists, it is possible that sod can be carefully removed, watered, and stored during construction operations, and replaced after the operations are completed since it is estimated that no section of pipeline must remain uncovered for more than two (2) days. Where the surface is disturbed in a newly seeded area, re-seed the area with the same quality and formula of seed as that used in the original seeding. Seeding must be done as directed, in all unsurfaced locations where sod and topsoil could not be preserved and replaced. The use of sod in lieu of seeding will require approval by the Contracting Officer or the Contracting Officer's

Representative, Technical Expert and Project Manager.

3.7.1.3 Restoration of Pavement

Repair pavement, sidewalks, curbs, and gutters where existing surfaces are removed or disturbed for construction. Saw cut pavement edges. Graded aggregate base course must have a maximum aggregate size of 1 1/2 inches. Prime base course with liquid asphalt, ASTM D2028/D2028M, Grade RC-70 prior to paving. Match base course thickness to existing but must not be less than 6 inches. Asphalt aggregate size must be 1/2 inch , asphalt cement must conform to ASTM D3381/D3381M, Grade AR-2000 . Match asphalt concrete thickness to existing but must not be less than 2 inches. Repair Portland cement concrete pavement, sidewalks, curbs, and gutters using 3,000 psi concrete conforming to ASTM C94/C94M Match existing pavement, sidewalk, curb, and gutter thicknesses.

3.7.1.4 Cleanup

The contractor is responsible for cleanup of the construction site. All paper bags, wire clippings, must be disposed of as directed. Paper bags, wire clippings and other waste will not be put in bell holes or anodes excavation.

3.7.2 Training

3.7.2.1 Instruction to Government Personnel

During the warranty testing or at a time designated by the Contracting Officer or the Contracting Officer's Representative, Technical Expert and Project Manager, make available the services of a technician regularly employed or authorized by the manufacturer of the Cathodic Protection System for instructing government personnel in the proper operation, maintenance, safety, and emergency procedures of the Cathodic Protection System. The period of instruction must be not less than four hours and not more than two 8-hour working day. Conduct the training at the jobsite or at another location mutually satisfactory to the government and the contractor. The field instructions will cover all of the items contained in the operation and maintenance manual.

-- End of Section --

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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(2014) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - IP	(2019) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM D4674 REV A	(2002; R 2010) Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments

EUROPEAN UNION (EU)

Directive 2011/65/EU	(2011) Restriction of the Use of Certain

	Hazardous Substances in Electrical and Electronic Equipment

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES LM-79	(2019) Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
ANSI/IES LM-80	(2020) Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
ANSI/IES LS-1	(2020) Lighting Science: Nomenclature and Definitions for Illuminating Engineering
ANSI/IES TM-15	(2020) Technical Memorandum: Luminaire Classification System for Outdoor Luminaires
ANSI/IES TM-21	(2021) Technical Memorandum: Projecting Long-TermLuminous, Photon, and Radiant Flux Maintenance of LED Light Sources
IES Lighting Library	IES Lighting Library

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 77	(2017) Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2017) Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products
NEMA C82.77-10	(2020) Harmonic Emission Limits - Related Power Quality Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA SSL 1	(2016) Electronic Drivers for LED Devices, Arrays, or Systems

NEMA SSL 3	(2011) High-Power White LED Binning for General Illumination
NEMA SSL 7A	(2015) Phase-Cut Dimming for Solid State Lighting: Basic Compatibility
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 7	(2011; R 2016; R 2021) Occupancy Motion Sensors Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 101	(2024) Life Safety Code
NFPA 110	(2022) Standard for Emergency and Standby Power Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-530-01	(2015; Change 3 2016) Interior and Exterior Lighting and Controls

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UL SOLUTIONS (UL)

UL 20	(2018; Reprint Jan 2021) UL Standard for Safety General-Use Snap Switches
UL 94	(2023; Reprint May 2023) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 844	(2012; Reprint Oct 2021) UL Standard for Safety Luminaires for Use in Hazardous (Classified) Locations
UL 916	(2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment
UL 924	(2016; Reprint Dec 2022) UL Standard for Safety Emergency Lighting and Power Equipment
UL 1472	(2015) UL Standard for Safety Solid-State Dimming Controls

UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires
UL 2043	(2013) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 8750	(2015; Reprint Sep 2021) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires, luminaire accessories, or lighting equipment are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires and accessories that are mounted in exterior environments and not attached to the exterior of the building are specified in Section 26 56 00 EXTERIOR LIGHTING. Commissioning requirements are specified in Section 01 91 00.15 BUILDING COMMISSIONING.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications and on the drawings, must be as defined in IEEE 100 and ANSI/IES LS-1.

b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in ANSI/IES LM-80.

c. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.

d. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings; G, DO

Sequence of Operation for Lighting Control System; G, DO

SD-03 Product Data

Luminaires; G, DO

Light Sources; G, DO

LED Drivers; G, DO

Luminaire Warranty; G, RO

Luminaire Design Data; G, DO

Lighting Controls Warranty; G, RO

Local Area Controller; G, DO

Lighting Contactor; G, DO

Switches; G, DO

Wall Box Dimmers; G, DO

Occupancy/Vacancy Sensors; G, DO

Photosensors; G, DO

Power Packs; G, DO

Power Hook Luminaire Hangers; G, DO

Exit Signs; G, DO

LED Emergency Lighting Transfer Switch; G, DO

Central Emergency Lighting System; G, DO

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

SD-06 Test Reports

ANSI/IES LM-79 Test Report; G, DO

ANSI/IES LM-80 Test Report; G, DO

ANSI/IES TM-21 Test Report; G, DO

Photosensor Verification Test; G, RO

SD-07 Certificates

LED Driver and Control System Interface Compatibility Certificate; G, RO

SD-10 Operation and Maintenance Data

End-User Training Plan; G, RO

1.4.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.5 QUALITY ASSURANCE

Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the IES Lighting Library as applicable, for the lighting system specified.

1.5.1 Luminaire Drawings

Include dimensions, accessories installation details, and construction details. Photometric data, including CRI, CCT, LED driver type, zonal lumen data, candlepower distribution data, and other data as identified by UFC 3-530-01 Paragraph 3-2 Lighting Calculations, must accompany shop drawings.

LLFs shall be as identified in Luminaire Schedules in column "FIO LLF".

LED Luminaires shall use a light loss factor (LLF) of 0.700 regardless of life beyond the required L70 value described in this specification section.

Include light loss factors by fixture type on the Luminaire Drawings.

Calculation points shall be located on grids with point spacing to be no greater than 1/3 the luminaire mounting height.

1.5.2 Luminaire Design Data

a. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified in accordance with the NFPA 70. Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

b. Provide long-term lumen maintenance projections for each LED luminaire in accordance with ANSI/IES TM-21. Data used for projections must be obtained from testing in accordance with ANSI/IES LM-80.

1.5.3 ANSI/IES LM-79 Test Report

Submit test report on manufacturer's standard production model of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data in IES format as outlined under "14.0 Test Report" in ANSI/IES LM-79.

1.5.4 ANSI/IES LM-80 Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "8.0 Test Report" in ANSI/IES LM-80.

1.5.5 ANSI/IES TM-21 Test Report

Submit test report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in ANSI/IES TM-21.

1.5.6 LED Driver and Control System Interface Compatibility Certificate

Submit certification from the luminaire, driver, or control system manufacturer that ensures compatibility and operability between devices.

1.5.7 Test Laboratories

Test laboratories for the ANSI/IES LM-79 and ANSI/IES LM-80 test reports must be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program for both LM-79 and LM-80 testing.

b. One of the qualified labs listed on the Department of Energy - LED Lighting Facts Approved Testing Laboratories List for LM-79 testing.

c. One of the EPA-Recognized Laboratories listed for LM-80 testing.

1.5.8 Regulatory Requirements

Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70, unless more stringent requirements are specified or indicated. Provide luminaires and assembled components that are approved by and bear the label of UL for the applicable location and conditions unless otherwise specified.

1.5.9 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products must have been in satisfactory commercial or industrial use for six months prior to bid opening. The six-month period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the six-month period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.9.1 Alternative Qualifications

Products having less than a six-month field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.9.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than six months prior to date of delivery to site, unless specified otherwise.

1.6 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.1 Luminaire Warranty

Provide and transfer to the government the original LED luminaire manufacturers standard commercial warranty for each different luminaire manufacturer used in the project.

a. Provide a written five year minimum replacement warranty for material, luminaire finish, and workmanship. Provide written warranty document that contains all warranty processing information needed, including customer service point of contact, whether or not a return authorization number is required, return shipping information, and closest return location to the luminaire location.

   (1) Finish warranty must include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

   (2) Material warranty must include:

      (a) All LED drivers and integral control equipment.

      (b) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) are defective, non-starting, or operating below 70 percent of specified lumen output.

b. Warranty period must begin in accordance with the manufacturer's standard warranty starting date.

c. Provide replacements that are promptly shipped, without charge, to the using Government facility point of contact and that are identical to or an improvement upon the original equipment. All replacements must include testing of new components and assembly.

1.6.2 Lighting Controls Warranty

Provide and transfer to the government the original lighting controls manufacturers standard commercial warranty for each different lighting controls manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Warranty service must be performed by a factory-trained engineer or technician.

a. Unless otherwise noted, provide a written five year minimum warranty on the complete system for all systems with factory commissioning. Provide warranty that covers 100 percent of the cost of any replacement parts and services required over the five years which are directly attributable to the product failure. Failures include, but are not limited to, the following:

(1) Software: Failure of input/output to execute switching or dimming commands.

(2) Damage of electronic components due to transient voltage surges.

(3) Failure of control devices, including but not limited to occupancy sensors, photosensors, and manual wall station control devices.

b. Provide a written five year minimum warranty on all input devices against defect in workmanship or materials provided by device manufacturer.

c. Provide a written five year minimum warranty on all control components attached to luminaires against defect in workmanship or materials.

1.7 COORDINATION

Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, cranes, fire alarm and suppression system, public address speakers, fire wall ratings, and partition assemblies.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES

UL 1598, NEMA C82.77-10. Provide luminaires as indicated in the luminaire schedule on EL600 and NL plates on EL601 or details on project plans, complete with light source, wattage, and lumen output indicated. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be specifically designed for use with the driver and light source provided.

Luminaires shall satisfy the provisions of the Buy American Act

2.2.1 Luminaires

UL 8750, ANSI/IES LM-79, ANSI/IES LM-80. For all luminaires, provide:

a. Complete system with LED drivers and light sources.

b. Housings constructed of non-corrosive materials. All new aluminum housings must be anodized or powder-coated. All new steel housings must be treated to be corrosion resistant.

c. ANSI/IES TM-21, ANSI/IES LM-80. Minimum L70 lumen maintenance value of 50,000 hours unless otherwise indicated in the luminaire schedule on EL600. Luminaire drive current value must be identical to that provided by test data for luminaire in question. "Projected" or "Reported" values per ANSI/IES TM-21 shall be used. "Calculated" values in excess of the ANSI/IES TM-21 "6x" testing time shall not be used. Laboratory testing shall be completed by a National Voluntary Laboratory Accreditation Program laboratory.

d. Minimum flux in lumens and maximum power in wattage as specified in the luminaire schedule. Theoretical models of initial lamp lumens per

watt are not acceptable.

e. UL listed for dry or damp location typical of interior installations. Any luminaire mounted on the exterior of the building must be UL listed for wet location typical of exterior installations.

f. LED driver and light source package, array, or module are accessible for service or replacement without removal or destruction of luminaire.

g. Lenses constructed of heat tempered borosilicate glass, UV-resistant acrylic, or silicone. Provide polycarbonate vandal-resistant lenses as indicated. Sandblasting, etching and polishing must be performed as indicated in the luminaire description.

h. ANSI/IES TM-15 Provide exterior building-mounted luminaires that do not exceed the BUG ratings as listed in the luminaire schedule. If BUG ratings are not listed in the luminaire schedule, provide luminaires that do not exceed B4-U0-G2.

i. LED fixtures with screw base light sources are not permitted.

2.2.2 Luminaires for Hazardous Locations

In addition to requirements stated herein, provide LED luminaires for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated.

2.3 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type, delivered lumen output, and wattage as indicated in the luminaire schedule on project plans.

2.3.1 LED Light Sources

Provide LED light sources that meet the following requirements:

a. NEMA ANSLG C78.377. Emit white light and have a nominal CCT as included on the luminaire schedule on EL600.

b. Minimum Color Rendering Index (CRI) of 80 for interior applications and 70 for exterior applications, except as noted on the luminaire schedules.

c. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

d. Light source color consistency by utilizing a binning tolerance within a 3-step McAdam ellipse.

2.4 LED DRIVERS

NEMA SSL 1, UL 8750. Provide LED drivers that are electronic, UL Class 1 or Class 2, constant-current type and that comply with the following requirements:

a. The combined driver and LED light source system does not exceed the minimum luminaire efficacy values as listed in the luminaire schedule provided.

b. Operates at a voltage of 120-277 volts at 50/60 hertz, with input voltage fluctuations of plus/minus 10 percent unless otherwise indicated in EL600 luminaire schedule.

c. Power Factor (PF) greater than or equal to 0.90 at full input power and across specified dimming range.

d. Maximum Total Harmonic Distortion (THD) less than 20 percent at full input power and across specified dimming range.

e. Operates for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

f. Withstands Category A surges of 2 kV without impairment of performance. Provide surge protection that is integral to the driver.

g. Integral thermal protection that reduces the output power to protect the driver and light source from damage if the case temperature approaches or exceeds the driver's maximum operating temperature.

h. 47 CFR 15. Complies with the requirements of the Federal Communications Commission (FCC) rules and regulations, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

i. Class A sound rating.

j. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

k. Provide dimming capability as indicated in the luminaire schedule or as control matrices dictate.

2.5 LIGHTING CONTROLS

UFC 3-530-01, ASHRAE 90.1 - IP, and ASHRAE 189.1. Provide lighting control system as indicated. Lighting control equipment shall include, if indicated: control modules, power packs, dimming ballasts, occupancy sensors, photocells, and light level sensors.

Wireless control devices and systems are prohibited such that even wireless components used in programming are not permissable to remain functional after installation.

2.5.1 System

Provide lighting control system that operates the lighting system as described in the lighting control strategies in the project plans. Submit Sequence of Operation for Lighting Control System describing the operation of the proposed lighting control system and devices. Sequence of Operation must provide the strategies identified in the lighting control strategies.

2.5.1.1 Localized Control Systems

Provide room or area-wide lighting control system capable of manual control, time-based control, and receiving input from photosensors and occupancy/vacancy sensors.

2.5.1.1.1 Local Area Controller

Provide controller designed for single area or room with the following requirements:

a. Operates at a voltage of 120-277 volts at 50/60 hertz.

b. Provide zones according to plans and lighting control matrices.

c. Provide inputs for occupancy/vacancy sensors, photosensors, and low-voltage wall switches.

d. Capable of 0-10V dimming as required by control matrices.

e. Provide override 'ON' function with input from Fire Alarm Control Panel for all emergency lighting. Controller must not turn off power to emergency batteries or exit signs.

2.5.2 Lighting Contactor

NEMA ICS 2. Provide an electrically-held lighting contactor housed in a enclosure conforming to NEMA ICS 6 for the environmental condition indicated on the plans. Provide contactor with quantity of single or double pole contacts as indicated on the drawings, rated 600 volts, 30 amps. Provide coil operating voltage matching the supply circuit voltage shown on the drawings.

Provide a Hand-Off-Auto switch on the exterior front face each contactor enclosure. Connect as indicated on control drawings.

2.5.3 Devices

2.5.3.1 Switches

Provide line-voltage toggle switches as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. When used for non-digital loads, devices must be rated at 20 Amps inductive load, and be compatible with the lighting control systems.

2.5.3.2 Wall Box Dimmers

UL 1472, UL 20, IEEE C62.41, NEMA 77, NEMA SSL 7A. Dimmers must provide flicker-free, continuously variable light output throughout the dimming range of at minimum 10 percent to 100 percent. Devices must be capable of operating at their full rated capacity regardless of being single or ganged-mounted, and be compatible with three-way and four-way switching scenarios.

Provide wall-box dimmers that meet the following requirements:

a. Device operates as part of a lighting control system or an independent control device as depicted on the plans.

b. Device operates with the use of a vertical slider, paddle, rotary, button, or toggle with adjacent vertical slider.

c. Finish of device matches switches and outlets in the same area.

d. Back box in wall has sufficient depth to accommodate body of switch

and wiring.

e. Dimmer is capable of controlling 0-10 volt LED drivers. Dimmers and the drivers they control must be provided from the same manufacturer or tested and certified as compatible for use together.

f. Radio frequency interference suppression is integral to device.

2.5.3.3 Occupancy/Vacancy Sensors

IEEE C62.41, NEMA WD 1, UL 94, UL 916, UL 508, ASTM D4674 REV A, NEMA WD 7. Provide occupancy/vacancy sensors with coverage patterns as indicated on project plans. Provide no less quantity of sensors as shown on plans, but add additional sensors when required to fulfill coverage requirement for the specific model of sensor provided. Provide vacancy sensor operation that requires manual control to activate luminaires and turns luminaires off after a set time of inactivity. Provide ceiling or wall-mounted occupancy/vacancy sensors that meet the following requirements:

a. Operating voltage of 12-24 or 120-277 volts.

b. Time delay of 30 seconds to 30 minutes with at least four intermediate time delay settings.

c. Sensors are as depicted on the plans.

e. Shielded or controlled by internal logic to adjust sensitivity to avoid false triggering due to ambient temperature, air temperature variations or HVAC air movement.

f. Sensor is equipped to automatically energize the connected load upon loss of normal power when located in a means of egress.

g. Occupancy and vacancy operation is field-adjustable and programmable with push-button or dip switch on the sensor device.

h. No leakage current to load when in the off mode.

i. Utilize zero-crossing circuitry to prevent damage from high inrush current and to promote long life operation.

2.5.3.3.1 Dual Technology Sensors

Provide dual technology sensors that meet the requirements for PIR sensors and ultrasonic sensors indicated above. If either the PIR or ultrasonic sensing registers occupancy, the luminaires must remain on.

2.5.3.3.2 Integrated Sensors

Provide integrated occupancy/vacancy sensors that mount directly to the luminaires as indicated in project plans.

2.5.3.3.3 Power Packs

UL 2043. Provide power packs to provide power to lighting control sensors as required in accordance with the manufacturer's specifications. Provide power packs that meet the following requirements:

a. Operate at an input voltage of 120-277 VAC, with an output voltage

12-24 VDC at 225 mA.

b. Constructed of plenum-rated, high-impact thermoplastic enclosure.

c. Utilizes zero-crossing circuitry to prevent damage from inrush current.

d. Maximum load rating of 16 amps for electronic lighting loads.

e. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

2.5.3.4 Photosensors

Provide photosensors that meet the following requirements:

a. Detect changes in ambient lighting level and enable dimming as required by sequence of operation by operating in a closed-loop system.

b. Contain a detection cone, where the base of the cone may be circular or an elongated shape, and where the smallest angle between the edge and the axis of the cone is between 20 and 50 degrees. The cone axis may be tilted to the vertical when installed to give the sensor preferred directionality.

c. Sensors are mounted as depicted on the plans with sensitivity, filtering, range and viewing angle to meet requirements of sequence of operation, scope of work and construction documents. Location and mounting to be per manufacturer's instructions.

d. Time delay that is adjustable from 1 to 30 seconds ON delay, and 1 to 30 minutes OFF delay to prevent cycling, with deadband adjustment of 25 percent to 100 percent above lower setpoint.

e. Output dimming signal is linear to light level with less than 1 percent variation. Cadmium sulfide photo-resistors are not acceptable.

f. Sensor is not combined in the same housing or location with occupancy or vacancy sensors if the proper location for one function compromises the successful operation of the other function, or in any way reduces the system's ability to meet the design intent.

g. Photocell shall be designed to fail to the ON position.

2.6 EXIT AND EMERGENCY LIGHTING EQUIPMENT

2.6.1 Exit Signs

UL 924, NFPA 101. Provide wattage as indicated in the luminaire schedule on project plans. Wire exit signs and emergency lighting units ahead of the local switch, to the normal lighting circuit located in the same room or area. Provide LED Exit Signs that meet the following criteria:

a. Housing constructed of UV-stable, thermo-plastic.

b. UL listed for damp location, unless otherwise noted on the plans.

c. Configured for mounting according the depiction on the plans.

d. 6 inch high, 3/4 inch stroke red lettering on face of sign with chevrons on either side of lettering to indicate direction.

e. Single or double face as indicated in project plans and luminaire schedule.

2.6.1.1 Exit Signs with Battery Backup

Equip with automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free nickel-cadmium type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 1-1/2 hours. LEDs must have a minimum rated life of 10 years. In lieu of battery, can use a nonradioactive photoluminescent plate.

2.6.2 LED Emergency Lighting Transfer Switch

UL 924, NFPA 101. Provide ELTS as depicted on the plans. ELTS to come with automatic power failure detection, test switch, and LED indicator (or combination switch/indicator). ELTS must be rated appropriate for environmental conditions as noted on E-series sheets and be warranted for a minimum of five years.

2.6.3 Self-Diagnostic Circuitry for LED Drivers

UL 924, NFPA 101. Provide emergency lighting unit with fully-automatic, integral self-testing/diagnostic electronic circuitry. Circuitry must provide for a one minute diagnostic test every 28 days, and a 30 minute diagnostic test every six months, minimum. Any malfunction of the unit must be indicated by LED(s) visible from the exterior of the luminaire. A manual test switch must also be provided to perform a diagnostic test at any given time.

2.6.4 Central Emergency Lighting System (CLI)

UL 924, NFPA 101, NFPA 110 level 1, NFPA 70. Provide a central power system providing emergency power at volts as depicted on plans, 60 hertz, for a minimum period of 90 minutes. Design the system to handle surges during loss and recovery of the voltage, and to deliver its full rated output to the designated lamp load. Provide batteries for power.

2.6.4.1 Operation

Provide system such that when the lighting system loses normal supply voltage, it automatically disengages itself from the normal input line, and switches to a self-contained inverter with built-in protection when the output is shorted or overloaded. Ensure that, when normal line voltage resumes, the emergency system automatically switches back to normal operation. Size the transfer switch for this function to handle 125 percent of full load. Provide the battery system with self-contained inverters with overload protection.

2.6.4.2 Charger

Provide a completely automatic battery charger that maintains the batteries in a fully charged condition and recharges the batteries to full capacity within 24 hours after full discharge in accordance with UL 924.

2.6.4.3 Batteries

Provide sealed lead-acid or nickel-cadmium batteries, maintenance-free for a period of not less than 10 years under normal operating conditions.

2.6.4.4 Accessories

Provide visual indicators to indicate normal power, inverter power, and battery-charger operation. Provide a low-voltage test switch to simulate power failure by interrupting the input line, voltage meter, electrolyte level detector to automatically disable the charging circuit in the event of a fault, and low-voltage cutoff to prevent extreme battery power dissipation.

2.6.4.5 Enclosure

Provide a free-standing cabinet with floor stand and constructed of 2.7 millimeter 12 -gage sheet steel with baked-on enamel finish and a locking latch.

2.7 LUMINAIRE MOUNTING ACCESSORIES

2.7.1 Suspended Luminaires

Coordinate with requirements of Section 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT. The stricter requirements shall apply.

a. Provide hangers capable of supporting twice the combined weight of luminaires supported by hangers.

b. Hangers must allow luminaires to swing within an angle of 45 degrees. Brace pendents 4 feet or longer to limit swinging.

c. Single-unit suspended luminaires must have cable hangers. Multiple-unit or continuous row luminaires with a separate power supply cord must have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end.

d. Provide all linear pendent and surface mounted luminaires with two supports per four-foot section or three per eight-foot section unless otherwise recommended by manufacturer.

2.7.2 Recess and Surface Mounted Luminaires

Provide access to light source and LED driver from bottom of luminaire. Provide trim and lenses for the exposed surface of flush-mounted luminaires as indicated on project drawings and specifications. Luminaires recessed in ceilings which have a fire resistive rating of one hour or more must be enclosed in a box which has a fire resistive rating equal to that of the ceiling. For surface mounted luminaires with brackets, provide flanged metal stem attached to outlet box, with threaded end suitable for supporting the luminaire rigidly in design position. Flanged part of luminaire stud must be of broad base type, secured to outlet box at not fewer than three points.

2.7.3 Luminaire Support Hardware

2.7.3.1 Wire

ASTM A641/A641M. Galvanized, soft tempered steel, minimum 0.11 inches in diameter, or galvanized, braided steel, minimum 0.08 inches in diameter.

2.7.3.2 Wire for Humid Spaces

ASTM A580/A580M. Composition 302 or 304, annealed stainless steel, minimum 0.11 inches in diameter.

ASTM B164. UNS NO4400, annealed nickel-copper alloy, minimum 0.11 inches in diameter.

2.7.3.3 Threaded Rods

Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.7.3.4 Straps

Galvanized steel, one by 3/16 inch, conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

2.7.4 Power Hook Luminaire Hangers

UL 1598. Where applicable, provide an assembly consisting of through-wired power hook housing, interlocking plug and receptacle, power cord, and luminaire support loop. Power hook housing must be cast aluminum having two 3/4 inch threaded hubs. Support hook must have safety screw. Luminaire support loop must be cast aluminum with provisions for accepting 3/4 inch threaded stems. Power cord must include 16 inches of 3 conductor No. 16 Type SO cord. Assembly must be rated 120 volts or 277 volts, 15 amperes.

2.8 EQUIPMENT IDENTIFICATION

2.8.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.8.2 Labels

UL 1598. All luminaires must be clearly marked for operation of specific light sources and LED drivers. The labels must be easy to read when standing next to the equipment, and durable to match the life of the equipment to which they are attached. Note the following light source characteristics in the format "Use Only _____":

a. Correlated Color Temperature (CCT) and Color Rendering Index (CRI) for all luminaires.

b. Driver and dimming protocol.

All markings related to light source type must be clear and located to be

readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. LED drivers must have clear markings indicating dimming type and indicate proper terminals for the various outputs.

2.9 FACTORY APPLIED FINISH

NEMA 250. Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum, meets requirements of corrosion-resistance testing.

PART 3 EXECUTION

3.1 INSTALLATION

IEEE C2, NFPA 70.

3.1.1 Light Sources

When light sources are not provided as an integral part of the luminaire, deliver light sources of the type, wattage, lumen output, color temperature (CCT), color rendering index (CRI), and voltage rating indicated to the project site and install just prior to project completion, if not already installed in the luminaires from the factory.

3.1.2 Luminaires

Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent luminaires and secure in accordance with manufacturers' directions and approved drawings. Provide accessories as required for ceiling construction type indicated on Finish Schedule. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed. Provide wires, straps, or rods for luminaire support in this section. Install luminaires with vent holes free of air blocking obstacles.

3.1.2.1 Suspended Luminaires

Measure mounting heights from the bottom of the luminaire for ceiling-mounted luminaires and to center of luminaire for wall-mounted luminaires. Obtain architect approval of the exact mounting height on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Support suspended luminaires from structural framework of ceiling or from inserts cast into slab.

a. Provide suspended luminaires with 45 degree swivel hangers so that they hang plumb and level.

b. Locate so that there are no obstructions within the 45 degree range in all directions.

c. The stem, canopy and luminaire must be capable of 45 degree swing.

d. Rigid pendent stem, aircraft cable, rods, or chains 4 feet or longer excluding luminaire must be braced to prevent swaying using three cables at 120 degree separation.

e. Suspended luminaires in continuous rows must have internal wireway

systems for end to end wiring and must be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces.

f. Utilize aligning splines on extruded aluminum luminaires to assure minimal hairline joints.

g. Support steel luminaires to prevent "oil-canning" effects.

h. Match supporting pendents with supported luminaire. Aircraft cable must be stainless steel.

i. Match finish of canopies to match the ceiling, and provide low profile canopies unless otherwise shown.

j. Maximum distance between suspension points must be 10 feet or as recommended by the manufacturer, whichever is less.

3.1.2.2 Recessed and Semi-Recessed Luminaires

a. Support recessed and semi-recessed luminaires independently from the building structure by a minimum of two wires, straps or rods per luminaire and located near opposite corners of the luminaire. Secure horizontal movement with clips provided by manufacturer. Ceiling grid clips are not allowed as an alternative to independently supported luminaires.

b. Support round luminaires or luminaires smaller in size than the ceiling grid independently from the building structure by a minimum of four wires, straps or rods per luminaire, spaced approximately equidistant around.

c. Do not support luminaires by acoustical tile ceiling panels.

d. Where luminaires of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support each independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the luminaire.

e. Luminaires installed in suspended ceilings must also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

f. Adjust aperture rings on all applicable ceiling recessed luminaires to accommodate various ceiling material thickness. Coordinate cut-out size in ceiling to ensure aperture covers cut-out entirely. Install aperture rings such that the bottom of the ring is flush with finished ceiling or not more than 1/16 inch above. Do not install luminaires such that the aperture ring extends below the finished ceiling surface.

3.1.2.3 Field Applied Painting

Paint lighting equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Provide painting as specified in Section 09 90 00 PAINTS AND COATINGS.

3.1.3 LED Drivers

Provide LED drivers integral to luminaire as constructed by the manufacturer.

3.1.4 Exit Signs

NFPA 101. Wire exit signs and emergency lighting units ahead of the local switch, to the normal lighting circuit located in the same room or area.

3.1.5 Lighting Controls

3.1.5.1 Scene Wallstations

Submit labeling templates for all scene wallstations, ganged faceplates and other manual control cover plates. Label each scene control button with approved scene description.

3.1.5.2 Occupancy/Vacancy Sensors

a. Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage must provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways.

b. Locate ceiling-mounted sensors no closer than 6 feet from the nearest HVAC supply or return diffuser.

c. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations.

3.1.5.3 Photosensors

Locate and aim sensor as indicated and in accordance with the manufacturer's recommendations. Adjust sensor set-point in accordance with the manufacturer's recommendations and for the indicated light level of the area of coverage, measured at the work plane.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

3.2.1.1 Lighting Control Verification Tests

Verify lighting control system and devices operate according to approved sequence of operations. Verification tests are to be completed after commissioning.

a. Verify occupancy/vacancy sensors operate as described in sequence of operations. Provide testing of sensor coverage, sensitivity, and time-out settings in all spaces where sensors are placed. This is to be completed only after all furnishings have been installed.

b. Verify photosensors operate as described in sequence of operations. Provide testing of sensor coverage, aiming, and calibration in all spaces where sensors are placed. This is to be completed only after all furnishings have been installed. Submit photosensor verification test.

c. Verify wall box dimmers and scene wallstations operate as described in sequence of operations.

3.2.1.2 Emergency Lighting Test

Interrupt power supply to demonstrate proper operation of emergency lighting. If adjustments are made to the lighting system, re-test system to show compliance with standards.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Commissioning

NFPA 101. Commission all components of the lighting system and lighting control system in accordance with Section 01 91 00.15 BUILDING COMMISSIONING. Factory Trained Field Service Technician is responsible for calibration and programming sequences for input devices and systems in accordance with the requirements described in the sequence of operation.

3.3.2 Training

3.3.2.1 End-User Training

Submit an End-User Training Plan at least 30 calendar days prior to training session that describes training procedures for end-users on the lighting control system. Provide users with a list of control devices located within user-occupied spaces, such as photosensors and occupancy and vacancy sensors, including information on the proper operation and schedule for each device. Provide demonstration for each type of interface. Provide users with the building schedule as currently commissioned, including conditional programming based on astronomic time clock functionality. Provide users with the correct contact information for maintenance personnel who will be available to address any lighting control issues.

-- End of Section --

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SECTION 26 56 00

EXTERIOR LIGHTING
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LTS	(2013; Errata 2013) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus

EUROPEAN UNION (EU)

Directive 2011/65/EU	(2011) Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES LM-79	(2019) Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
ANSI/IES LM-80	(2020) Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
ANSI/IES LS-1	(2020) Lighting Science: Nomenclature and Definitions for Illuminating Engineering
ANSI/IES RP-8	(2018; Addenda 1 2020; Errata 1-2 2021) Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting
ANSI/IES TM-15	(2020) Technical Memorandum: Luminaire Classification System for Outdoor Luminaires

ANSI/IES TM-21	(2021) Technical Memorandum: Projecting Long-TermLuminous, Photon, and Radiant Flux Maintenance of LED Light Sources
IES Lighting Library	IES Lighting Library

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C136.3	(2020) Roadway and Area Lighting Equipment - Luminaire Attachments
ANSI C136.13	(2020) Roadway and Area Lighting Equipment - Metal Brackets for Wood Poles
ANSI C136.21	(2014) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2017) Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products
NEMA C82.77-10	(2020) Harmonic Emission Limits - Related Power Quality Requirements
NEMA C136.31	(2018) Roadway and Area Lighting Equipment - Luminaire Vibration
NEMA SSL 1	(2016) Electronic Drivers for LED Devices, Arrays, or Systems
NEMA SSL 3	(2011) High-Power White LED Binning for General Illumination

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

UL SOLUTIONS (UL)

UL 773	(2016; Reprint Jul 2020) UL Standard for Safety Plug-In, Locking Type Photocontrols for Use with Area Lighting

UL 773A	(2016; Reprint Jun 2020) UL Standard for Safety Nonindustrial Photoelectric Switches for Lighting Control
UL 1310	(2018; Reprint Jun 2022) UL Standard for Safety Class 2 Power Units
UL 1598	(2021; Reprint Jan 2024) UL Standard for Safety Luminaires
UL 8750	(2015; Reprint Sep 2021) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires, luminaire accessories, or lighting equipment are specified in Section(s) 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION . Luminaires and accessories installed in interior of buildings or attached to the exterior of a building are specified in Section 26 51 00 INTERIOR LIGHTING. Commissioning requirements are specified in Section 01 91 00.15 BUILDING COMMISSIONING

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications and on the drawings must be as defined in IEEE 100 and ANSI/IES LS-1.

b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in ANSI/IES LM-80.

c. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.

d. Total Harmonic Distortion (THD) is the Root Mean Square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings; G, DO

Pole Drawings; G, DO

SD-03 Product Data

Luminaires; G, DO

Light Sources; G, DO

LED Drivers; G, DO

Luminaire Warranty; G, RO

Lighting Controls Warranty; G, RO

Pole Warranty; G, RO

Photosensors; G, DO

Poles; G, DO

Brackets; G, DO

SD-05 Design Data

Luminaire Design Data; G, DO

SD-06 Test Reports

ANSI/IES LM-79 Test Report; G, DO

ANSI/IES LM-80 Test Report; G, DO

ANSI/IES TM-21 Test Report; G, DO

SD-08 Manufacturer's Instructions

Poles; G, RO

SD-10 Operation and Maintenance Data

Exterior Lighting Control System; G, DO

Maintenance Staff Training Plan; G, RO

End-User Training Plan; G, RO

1.4.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.5 QUALITY ASSURANCE

Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the IES Lighting Library as applicable, for the lighting system specified.

1.5.1 Drawing Requirements

1.5.1.1 Luminaire Drawings

Include dimensions, accessories, and installation and construction details. Photometric data, including CRI, CCT, TM-15-11 BUG rating, LED driver type, aiming diagram, zonal lumen data, and candlepower distribution data per LM-79 must accompany shop drawings.

1.5.1.2 Pole Drawings

Include dimensions, wind load determined in accordance with AASHTO LTS, pole deflection, pole class, and other applicable information.

1.5.2 Luminaire Design Data

a. Provide distribution data according to IES classification type as defined in IES Lighting Library and ANSI/IES RP-8.

b. B.U.G. rating for the installed position as defined by ANSI/IES TM-15 and shielding as defined by ANSI/IES RP-8.

c. Provide safety certification and file number for the luminaire family. Include listing, labeling and identification in accordance with NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

d. Provide long term lumen maintenance projections for each LED luminaire in accordance with ANSI/IES TM-21. Data used for projections must be obtained from testing in accordance with ANSI/IES LM-80.

e. Provide wind loading calculations for luminaires mounted on poles. Weight and effective projected area (EPA) of luminaires and mounting brackets must not exceed maximum rating of pole as installed in particular wind zone area.

1.5.3 ANSI/IES LM-79 Test Report

Submit test report on manufacturer's standard production model of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "14.0 Test Report" in ANSI/IES LM-79.

1.5.4 ANSI/IES LM-80 Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "8.0 Test Report" in ANSI/IES LM-80.

1.5.5 ANSI/IES TM-21 Test Report

Submit test report on manufacturer's standard production LED light source (package, array or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire.

Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in ANSI/IES TM-21.

1.5.6 Test Laboratories

Test laboratories for the ANSI/IES LM-79 and ANSI/IES LM-80 test reports must be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program.

b. One of the qualified labs listed on the Department of Energy - Energy Efficiency & Renewable Energy, Solid-State Lighting web site.

c. One of the EPA-Recognized Laboratories listed at for LM-80 testing.

1.5.7 Regulatory Requirements

Equipment, materials, installation, and workmanship must be in accordance with the mandatory provisions of NFPA 70 unless more stringent requirements are specified or indicated. Provide luminaires and assembled components that are approved by and bear the label of UL for the applicable location and conditions unless otherwise specified.

1.5.8 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for six months prior to bid opening. The six-month period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the six-month period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.8.1 Alternative Qualifications

Products having less than a six-month field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.8.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than six months prior to date of delivery to site, unless specified otherwise.

1.6 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.1 Luminaire Warranty

Provide and transfer to the government the original LED luminaire manufacturers standard commercial warranty for each different luminaire manufacturer used in the project.

a. Provide a written five year minimum replacement warranty for material, luminaire finish, and workmanship. Provide written warranty document that contains all warranty processing information needed, including customer service point of contact, whether or not a return authorization number is required, return shipping information, and closest return location to the luminaire location.

(1) Finish warranty must include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

(2) Material warranty must include:

(a) All LED drivers and integral control equipment.

(b) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) are defective, non-starting, or operating below 70 percent of specified lumen output.

b. Warranty period must begin in accordance with the manufacturer's standard warranty starting date.

c. Provide replacements that are promptly shipped, without charge, to the using Government facility point of contact and that are identical to or an improvement upon the original equipment. All replacements must include testing of new components and installation.

1.6.2 Lighting Controls Warranty

Provide and transfer to the government the original lighting controls manufacturers standard commercial warranty for each different lighting controls manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Warranty service must be performed by a factory-trained engineer or technician.

a. Unless otherwise noted, provide a written five year minimum warranty on the complete system for all systems with factory commissioning. Provide warranty that covers 100 percent of the cost of any replacement parts and services required over the five years which are directly attributable to the product failure. Failures include, but are not limited to, the following:

(1) Software: Failure of input/output to execute switching or dimming commands.

(2) Damage of electronic components due to transient voltage surges.

(3) Failure of control devices, including but not limited to photosensors and motion sensors.

b. Provide a written five year minimum warranty on all input devices against defect in workmanship or materials provided by device manufacturer.

c. Provide a written five year minimum warranty on all control components attached to luminaires against defect in workmanship or materials.

1.6.3 Pole Warranty

Provide and transfer to the government the original pole manufacturers standard commercial warranty for each different pole manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Provide a written three year minimum replacement warranty for material, luminaire finish, and workmanship. Warranty service must be performed by a factory-trained engineer or technician.

1.7 OPERATION AND MAINTENANCE MANUALS

1.7.1 Lighting System

Provide operation and maintenance manuals for the lighting system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting system. Include the following:

a. Manufacturers' operating and maintenance manuals.

b. Luminaire shop drawings for modified and custom luminaires.

c. Luminaire Manufacturers' standard commercial warranty information as specified in paragraph LUMINAIRE WARRANTY.

1.7.2 Exterior Lighting Control System

Provide operation and maintenance manuals for the exterior lighting control system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the exterior lighting control system. Include the following:

a. Control System One-Line Diagram

b. Product data for all devices, including installation and programming instructions.

c. Training materials, such as videos or in-depth manuals, that cover basic operation of the lighting control system and instructions on modifying the control system. Training materials must include calibration, adjustment, troubleshooting, maintenance, repair, and replacement.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES

UL 1598, NEMA C82.77-10. Provide luminaires as indicated in the luminaire schedule and XL plates or details on project plans, complete with light source, wattage, and lumen output indicated. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be

specifically designed for use with the LED driver and light source provided.

2.2.1 Luminaires

UL 8750, ANSI/IES LM-79, ANSI/IES LM-80. For all luminaires, provide:

a. Complete system with LED drivers and light sources.

b. Housing constructed of non-corrosive materials. All new aluminum housings must be anodized or powder-coated. All new steel housings must be treated to be corrosion resistant.

c. ANSI/IES TM-21, ANSI/IES LM-80. Minimum L70 lumen maintenance value of 50,000 hours unless otherwise indicated in the luminaire schedule on ES111. Luminaire drive current value must be identical to that provided by test data for luminaire in question. "Projected" or "Reported" values per ANSI/IES TM-21 shall be used. "Calculated" values in excess of the ANSI/IES TM-21 "6x" testing time shall not be used. Laboratory testing shall be completed by a National Voluntary Laboratory Accreditation Program laboratory.

d. Minimum flux in lumens and maximum power in wattage as specified in the luminaire schedule. Theoretical models of initial lamp lumens per watt are not acceptable.

e. Product rated for operation within an ambient temperature range of minus 22 degrees F to 104 degrees F.

f. UL listed for wet locations.

g. IES Lighting Library. Light distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans.

h. Housing finish that is baked-on enamel, anodized, or baked-on powder coat paint. Finish must be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.

i. LED driver and light source package, array, or module are accessible for service or replacement without removal or destruction of luminaire.

j. ANSI/IES TM-15 Provide exterior building-mounted luminaires that do not exceed the BUG ratings as listed in the luminaire schedule. If BUG ratings are not listed in the luminaire schedule, provide luminaires that do not exceed B4-U0-G2.

k. Fully assembled and electrically tested prior to shipment from factory.

l. Finish color is as indicated in the luminaire schedule or detail on the project plans.

m. Lenses constructed of clear tempered glass or UV-resistant acrylic.

n. All factory electrical connections are made using crimp, locking, or latching style connectors. Twist-style wire nuts are not acceptable.

o. NEMA C136.31. Comply with 3G vibration testing.

2.3 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type, lumen rating, and wattage as indicated in luminaire schedule on project plans.

2.3.1 LED Light Sources

Provide LED light sources that meet the following requirements:

a. NEMA ANSLG C78.377. Emit white light and have a nominal Correlated Color Temperature (CCT) as depicted on luminaire schedule on EL111D.

b. Minimum Color Rendering Index (CRI) as depicted on luminaire schedule on EL111D.

c. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

d. Light source color consistency by utilizing a binning tolerance within a 4-step McAdam ellipse.

2.4 LED DRIVERS

NEMA SSL 1, UL 1310. Provide LED Drivers that are electronic, UL Class 1 or Class 2, constant-current type and meet the following requirements:

a. The combined LED driver and LED light source system is greater than or equal to the minimum luminaire efficacy values as listed in the luminaire schedule provided.

b. Operate at a voltage of 120-277 volts at 50/60 hertz, with input voltage fluctuations of plus or minus 10 percent.

c. Power Factor (PF) greater than or equal to 0.90 at full input power and across specified dimming range.

d. Maximum Total Harmonic Distortion (THD) less than or equal to 20 percent at full input power and across specified dimming range.

e. Operates for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

f. Meets the "Elevated" (10kV/10kA) requirements per IEEE C62.41.2 -2002. Manufacturer must indicate whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire. Provide surge protection that is integral to the LED driver.

g. Contains integral thermal protection that reduces the output power to protect the driver and light source from damage if the case temperature approaches or exceeds the driver's maximum operating temperature.

h. Complies with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

i. Class A sound rating for all drivers mounted under a covered structure, such as a canopy, or where otherwise appropriate.

j. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

k. UL listed for wet locations typical of exterior installations.

l. Dimmable, and compatible with a standard dimming control circuit of 0 - 10V.

m. Rated to operate between ambient temperatures of minus 22 degrees F and 104 degrees F.

2.5 LIGHTING CONTROLS

2.5.1 System

Provide exterior lighting control system that operates the exterior lighting system as described in the exterior lighting control strategies in the project plans.

Wireless control devices and systems are prohibited such that even wireless components used in programming are not permissable to remain functional after installation.

2.5.2 Devices

2.5.2.1 Photosensors

UL 773, UL 773A. Provide Photosensors that meet the following requirements:

a. Hermetically sealed, cadmium sulfide or silicon diode light sensor type 277 volts, 50/60 Hz with single-pole, single-throw contacts.

b. Turns ON at 1 to 3 footcandles and turns OFF at 3 to 15 footcandles.

c. Designed to fail to the ON position.

d. Housing is constructed of die cast aluminum, rated to operate within a temperature range of minus 40 to 158 degrees F.

e. Time delay that prevents accidental switching from transient light sources.

g. Designed for 20-year service to match life expectancy of long-life LED fixtures and exceed 15,000 operations at full load. Provide photosensors with zero-cross technology to withstand severe in-rush current and extend relay life.

j. Provide photosensors with metal oxide varistor (MOV) type surge protection.

2.6 POLES

AASHTO LTS. Provide round tapered poles designed for wind loading of 100 miles per hour while supporting luminaires and all other appurtenances indicated. The effective projected areas (EPA) of luminaires and appurtenances used in calculations must be specific for the actual products provided on each pole. Provide poles that are embedded-base type

designed for use with underground supply conductors. Poles must have oval-shaped hand hole having a minimum clear opening of 3 by 5 inches. Secure hand hole covers by stainless steel captive screws. Provide metal poles with an internal grounding connection accessible from the hand hole near the bottom of each pole. Install a means of wire disconnection accessible from the hand hole. Do not install square poles. Provide poles from a Manufacturer with a standard provision for protecting the finish during shipment and installation. Do not install scratched, stained, chipped, or dented poles.

2.6.1 Brackets and Supports

ANSI C136.3, ANSI C136.13, and ANSI C136.21. Provide pole brackets that are not less than 1 1/4 inch galvanized steel pipe secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets must be coordinated to luminaires provided, and brackets for use with one type of luminaire must be identical. Brackets for pole-mounted street lights must correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 24 feet above street. Provide special mountings or brackets as indicated and of metal which will not promote galvanic reaction with luminaire head.

2.6.2 Pole Foundations

Provide anchor bolts consisting of a steel rod with a minimum yield strength of 50,000 psi; the top 12 inches of the rod must be galvanized in accordance with ASTM A153/A153M. Concrete must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE and Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.7 EQUIPMENT IDENTIFICATION

2.7.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.7.2 Labels

UL 1598. Luminaires must be clearly marked for operation of specific light sources and drivers according to proper light source type. Note the following luminaire characteristics in the format "Use Only _____":

a. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

b. Driver and dimming protocol.

Markings related to light source type must be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. LED drivers must have clear markings indicating dimming type and indicate proper terminals for the various outputs.

2.8 FACTORY APPLIED FINISH

NEMA 250. Provide all luminaires and lighting equipment with

factory-applied painting system that as a minimum meets requirements of corrosion-resistance testing.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Luminaires

Install all luminaires in accordance with the luminaire manufacturer's written instructions. Install all luminaires at locations and heights as indicated on the project plans. Level all luminaires in accordance to manufacturer's written instructions. Aim all luminaires in accordance with aiming diagram.

3.1.2 LED Drivers

Provide LED drivers integral to luminaire as constructed by the manufacturer.

3.1.3 Field-Applied Painting

Provide field applied painting for luminaires. Paint lighting equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Provide painting as specified in Section 09 90 00 PAINTS AND COATINGS.

3.1.4 Pole Setting

Set pole to depth as indicated.

3.1.5 Lighting Controls

Additional lighting control installation requirements.

3.1.5.1 Photosensors

Aim photosensor according to manufacturer's recommendations.

3.1.5.2 Motion Sensors

Locate sensors in accordance with the manufacturer's recommendation. Locate sensors to achieve coverage of areas as indicated on project plans. Coverage patterns must be derated as recommended by manufacturer based on mounting height of sensor and any obstructions such as trees. Do not use gross rated coverage in manufacturer's product literature.

3.1.6 Grounding

Ground noncurrent-carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Perform initial operational test, consisting of the entire system energized for 72 consecutive hours without any failures of any kind occurring in the system. All circuits must test clear of faults, grounds, and open circuits.

3.2.1.1 Lighting Control Verification Test

Verify lighting control system and devices operate according to approved sequence of operations. Verification tests are to be completed after commissioning.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Training

Provide on-site training to the Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide training that includes calibration, adjustment, troubleshooting, maintenance, repair, and replacement.

3.3.1.1 Maintenance Staff Training

Submit a Maintenance Staff Training Plan at least 30 calendar days prior to training session that describes training procedures for Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide on-site training which demonstrate full system functionality, assigning schedules, calibration adjustments for light levels and sensor sensitivity, integration procedures for connecting to third-party devices, and manual override including information on appropriate use. Provide protocols for troubleshooting, maintenance, repair, and replacement, and literature on available system updates and process for implementing updates.

3.3.1.2 End-User Training

Submit a End-User Training Plan at least 30 calendar days prior to training session that describes training procedures for end-users on the lighting control system. Provide demonstration for each type of user interface. Provide users with the curfew schedule as currently commissioned, including conditional programming based on astronomic time clock functionality. Provide users with the correct contact information for maintenance personnel who will be available to address any lighting control issues.

-- End of Section --

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SECTION 27 10 00

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SECTION 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E	(2005) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-83-596	(2021) Indoor Optical Cable
ICEA S-90-661	(2021) Category 3 and 5E Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and LAN Communications Wiring Systems

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA/BICSI 568	(2006) Standard for Installing Building Telecommunications Cabling

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 66	(2019) Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pairs
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-21	(1988a; R 2012) FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices
TIA-526-7	(2015a; R 2022) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures - Part 4-2: Installed Cable Plant - Single-Mode Attenuation and Optical Return Loss Measurement
TIA-568.0	(2020e) Generic Telecommunications Cabling for Customer Premises
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2	(2018d) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	(2022e) Optical Fiber Cabling Components Standard
TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces
TIA-570	(2012c) Residential Telecommunications Infrastructure Standard
TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
TIA-1152	(2016; R 2021) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
TIA/EIA-598	(2014D; Add 2 2018) Optical Fiber Cable Color Coding
TIA/EIA-604-10	(2002a) FOCIS 10 Fiber Optic Connector Intermateability Standard - Type LC

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-580-01	(2016; Change 1 2016) Telecommunications Interior Infrastructure Planning and Design

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 68	Connection of Terminal Equipment to the

	Telephone Network (47 CFR 68)

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 444	(2017; Reprint Jun 2021) UL Standard for Safety Communications Cables
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 723	(2020) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 969	(2017; Reprint May 2023) UL Standard for Safety Marking and Labeling Systems
UL 1286	(2022) UL Standard for Safety Office Furnishings
UL 1666	(2007; Reprint Sep 2021) UL Standard for Safety Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
UL 1863	(2004; Reprint Oct 2019) UL Standard for Safety Communication Circuit Accessories

1.2 RELATED REQUIREMENTS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and Section, UFC 3-580-01, 33 82 00 TELECOMMUNICATIONS, OUTSIDE PLANT (OSP), apply to this section with additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568.1, TIA-568.2, TIA-568.3, TIA-569, TIA-606 and IEEE 100 and herein.

1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect (MC).)

1.3.2 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect (IC).)

1.3.3 Floor Distributor (FD)

A distributor used to connect horizontal cable and cabling subsystems or equipment. (International expression for horizontal cross-connect (HC).)

1.3.4 Telecommunications Room (TR)

An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

1.3.5 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including wireless) including the entrance point at the building wall and continuing to the equipment room.

1.3.6 Equipment Room (ER) (Telecommunications)

An environmentally controlled centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.3.7 Open Cable

Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

1.3.8 Open Office

A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

1.3.9 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

The building telecommunications cabling and pathway system shall include permanently installed backbone and horizontal cabling, horizontal and backbone pathways, service entrance facilities, work area pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport telephone and data (including LAN) between equipment items in a building, compliant with UFC 3-580-01 and other references herein. The horizontal system shall be wired in a star topology from the telecommunications work area to the floor distributor or campus distributor at the center or hub of the star. The backbone cabling and pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware. The intrabuilding backbone provides connectivity from the floor distributors to the building distributors or to the campus distributor and from the building distributors to the campus distributor as required. The backbone system shall be wired in a star topology with the campus distributor at the center or hub of the star. The

interbuilding backbone system provides connectivity between the campus distributors and is specified in Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP). Provide telecommunications pathway systems referenced herein as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Underground Conduit Routing Plan; G, DO

Telecommunications Drawings; G, DO

Telecommunications Space Drawings; G, DO

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Telecommunications Cabling (backbone and horizontal); G, RO

Patch Panels; G, RO

Telecommunications Outlet/Connector Assemblies; G, RO

Equipment Support Frame; G, RO

Connector Blocks; G, RO

Spare Parts; G, RO

Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Telecommunications Cabling Testing; G, RO

SD-07 Certificates

Telecommunications Contractor Qualifications; G, RO

Key Personnel Qualifications; G, RO

Manufacturer Qualifications; G, RO

Test Plan; G, RO

SD-09 Manufacturer's Field Reports

Factory Reel Tests; G, RO

SD-10 Operation and Maintenance Data

Telecommunications Cabling and Pathway System Data Package 5; G, RO

SD-11 Closeout Submittals

Record Documentation; G, RO

1.5.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawings

In exception to Section 01 33 00 SUBMITTAL PROCEDURES, submitted plan drawings shall be a minimum of 11 by 17 inches in size using a minimum scale of 1/8 inch per foot, except as specified otherwise. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Drawings

Provide registered communications distribution designer (RCDD) approved, drawings in accordance with TIA-606. The identifier for each termination and cable shall appear on the drawings. Drawings shall depict final telecommunications installed wiring system infrastructure in accordance with TIA-606. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the EF telecommunications and ER telecommunications, CD's, BD's, and FD's to the telecommunications work area outlets. Provide a plastic laminated schematic of the as-installed telecommunications cable system showing cabling, CD's, BD's, FD's, and the EF and ER for telecommunications keyed to floor plans by room number. Mount the laminated schematic in the EF telecommunications space as directed by the Contracting Officer. The following drawings shall be provided as a minimum:

a. T1 - Layout of complete building per floor - Building Area/Serving

Zone Boundaries, Backbone Systems, and Horizontal Pathways. Layout of complete building per floor. The drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.

b. T2 - Serving Zones/Building Area Drawings - Drop Locations and Cable Identification (ID'S). Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.

c. T4 - Typical Detail Drawings - Faceplate Labeling, Firestopping, Americans with Disabilities Act (ADA), Safety, Department of Transportation (DOT). Detailed drawings of symbols and typicals such as faceplate labeling, faceplate types, faceplate population installation procedures, detail racking, and raceways.

1.6.1.2 Telecommunications Space Drawings

Provide T3 drawings in accordance with TIA-606 that include telecommunications rooms plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and cabinet, rack, backboard and wall elevations. Drawings shall show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings shall include a complete list of equipment and material, equipment rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of T1 or T2 drawings.

1.6.2 Telecommunications Qualifications

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years of similar scope and size. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.

1.6.2.2 Key Personnel

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified

telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.

In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from the Contracting Officer.

1.6.2.3 Minimum Manufacturer Qualifications

Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with TIA-568.1, TIA-568.2 and TIA-568.3.

1.6.3 Test Plan

Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the components and accessories for each cable type specified, 60 days prior to the proposed test date. Include procedures for certification, validation, and testing.

1.6.3.1 Test Reports

Provide test reports, in native and PDF format, for each fiber cable installed. In addition to cable test data, each report must indicate the project name, date and time of test, personnel performing the test, software version of cable limits and equipment, and calibration dates of all equipment. Results must include equipment reference testing required when changing equipment locations, when reference cords are removed from equipment, and the start of new testing shifts. Cable ID's on each test result must match those provided in T4 approved submittals.

1.6.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.5 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.5.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.5.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 DELIVERY AND STORAGE

Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.

1.8 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.10 MAINTENANCE

1.10.1 Operation and Maintenance Manuals

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications cabling and pathway system, Data Package 5. Submit operations and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data Package 5, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, TELECOMMUNICATIONS SPACE DRAWINGS, and RECORD DOCUMENTATION. Ensure that these drawings and documents depict the as-built configuration.

1.10.2 Record Documentation

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA-606. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum. T5 drawings shall be provided on electronic media using Windows based computer cable management software. A licensed copy of the cable management software including documentation, shall be provided. Provide the following T5 drawing documentation as a minimum:

a. Cables - A record of installed cable shall be provided in accordance with TIA-606. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with TIA-606. Include manufacture date of cable with submittal.

b. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance with TIA-606. Documentation shall include the required data fields as a minimum in accordance with TIA-606.

c. Cable Schedule - Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

d. Cabling Administration Drawings - Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

1.10.3 Spare Parts

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

1.11 Underground Conduit Routing Plan

Provide a plan expressing conduits routing underground both within the footprint of the building and those entering and/or exiting the building footprint (including those captured be Section 33 82 00). See coordinated submittal requirements regarding this submittal item with respect to impacted submittal content by other trades, most notably alterations and accommodations of footing reinforcement for conduit and ductbank with vertical routing through the footings.

PART 2 PRODUCTS

2.1 COMPONENTS

Components shall be UL or third party certified. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide a complete system of telecommunications cabling and pathway components using star topology. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets/racks. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.

2.2 TELECOMMUNICATIONS PATHWAY

Provide telecommunications pathways in accordance with TIA-569 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide system furniture pathways in accordance with UL 1286.

2.3 TELECOMMUNICATIONS CABLING

Cabling shall be UL listed for the application and shall comply with TIA-568.0, TIA-568.1, TIA-568.2, TIA-568.3 and NFPA 70. Provide a labeling system for cabling as required by TIA-606 and UL 969. Ship cable on reels or in boxes bearing manufacture date for for unshielded twisted pair (UTP) in accordance with ICEA S-90-661 and optical fiber cables in accordance with ICEA S-83-596 for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.

2.3.1 Backbone Cabling

2.3.1.1 Backbone Copper

Copper backbone cable shall be solid conductor, 24 AWG, 100 ohm, 100 -pair, Category 3, UTP, in accordance with ICEA S-90-661, TIA-568.1, TIA-568.2 and UL 444, formed into 25 pair binder groups covered with a gray thermoplastic jacket and overall metallic shield. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular length marking intervals in accordance with ICEA S-90-661 . Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG)communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70.

Backbone copper routed below the finished floor on the first floor shall be UL listed for wet locations.

2.3.1.2 Backbone Optical Fiber

Provide in accordance with ICEA S-83-596, TIA-568.3, UL 1666 and NFPA 70. Cable shall be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 40 inches.

Provide the number of strands indicated, (but not less than 12 strands between the main telecommunication room and each of the other telecommunication rooms), of single-mode(OS1), tight buffered fiber optic cable.

Provide tight buffered fiber optic multimode, 50/125-um diameter laser optimized(OM3) cable in the number of strands as indicated.

Provide plenum (OFNP), riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color shall be in accordance with TIA/EIA-598.

Provide plenum (OFNP) riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color shall be in accordance with TIA/EIA-598.

Backbone fiber routed below the finished floor on the first floor shall be UL listed for wet locations.

2.3.1.2.1 Fiber Optic Cable Splices

No fiber splices shall occur in this facility. All fiber shall be home run cabling.

2.3.1.2.2 Shield Connectors

Provide connectors with a stable, low-impedance electrical connection between the cable shield and the bonding conductor in accordance with RUS Bull 345-65.

2.3.2 Horizontal Cabling

Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568.1.

2.3.2.1 Horizontal Copper

Provide horizontal copper cable, UTP, 100 ohm in accordance with TIA-568.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661 . Provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6A, with a thermoplastic jacket of color(s) indicated on Sheet TN500. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG) communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs shall be UL listed and labeled for wet locations in accordance with NFPA 70.

2.3.3 Work Area Cabling

2.3.3.1 Work Area Copper

Provide work area copper cable in accordance with TIA-568.2, with a thermoplastic jacket of color(s) indicated on Sheet TN500.

2.4 TELECOMMUNICATIONS SPACES

Provide connecting hardware and termination equipment in the telecommunications entrance facility and telecommunication equipment room to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunications interconnecting hardware color coding in accordance with TIA-606.

2.4.1 Backboards

Provide void-free, interior grade A-C plywood 3/4 inch thick4 by 8 feet . Backboards shall be fire rated by manufacturing process. Fire stamp shall be clearly visible. Paint applied over fire retardant backboard shall be UL 723 fire retardant paint. Provide label including paint manufacturer, date painted, UL listing and name of Installer. When painted, paint label and fire stamp shall be clearly visible. Backboards shall be provided on a minimum of two adjacent walls in the telecommunication spaces. Backboards shall be provided on walls indicated in the room finish schedules (Architectural sheets) and as indicated on TN/EP plans.

2.4.2 Equipment Support Frame

Provide in accordance with ECIA EIA/ECA 310-E and UL 50.

a. Bracket, wall mounted, 8 gauge aluminum. Provide hinged bracket compatible with19 inches panel mounting.

b. Racks, floor mounted modular type, 16 gauge steel or 11 gauge aluminum construction, minimum, treated to resist corrosion. Provide seven-foot-high (7'-0") rack with vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and receptacles with dedicated power circuits as indicated on drawings. Rack shall be compatible with19 inches panel mounting. Racks shall be separated by a minimum of 6 inches.

c. Cabinets, freestanding modular type, minimum 16 gauge steel or 11 gauge aluminum construction, minimum, treated to resist corrosion. Cabinet shall have removable and lockable side panels, front and rear doors, and have adjustable feet for leveling. Cabinet shall be vented in the roof and rear door. Cabinet shall have cable access in the roof and base and be compatible with19 inches panel mounting. Provide cabinet with grounding bar rack mounted 550 CFM fan with filter . All cabinets shall be keyed alike.

d. Cabinets, wall-mounted double-hinge type telecommunications enclosure (DHTE), doors shall be made of minimum 16 gauge steel and body made of minimum 14 guage steel construction, minimum, treated to resist corrosion.Cabinets shall be minimum NEMA ICS 6 Type 4 (minimum IP66) construction with solid doors. Cabinet shall have have lockable front door, , attached air conditioning unit, ground lug, and top and bottom cable access. Cabinet shall be compatible with19 inches panel mounting. All cabinets shall be keyed alike. Receptacles with dedicated power circuits as indicated on drawings shall be provided at the cabinet.

2.4.3 Connector Blocks

Provide insulation displacement connector (IDC) Type 110 for Category 6 systems. Provide blocks for the number of horizontal and backbone cables terminated on the block plus 25 percent spare.

2.4.4 Cable Guides

Provide cable guides specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on 19 inches equipment racks and telecommunications backboards. Cable guides of ring or bracket type devices mounted on rack panels for horizontal cable management and individually mounted for vertical cable management. Mount cable guides with screws, or nuts and lockwashers.

2.4.4.1 Cable Management for Equipment Frames

1. Metal or plastic, with integral wire retaining fingers.

2. Vertical cable management panels shall have front and rear channels, with covers.

3. Provide horizontal crossover cable manager at the top and bottom of each relay rack, with a minimum height of two rack units each.

2.4.5 Patch Panels

Provide ports for the number of horizontal and backbone cables terminated on the panel plus 25 percent spare. Provide pre-connectorized optical fiber and copper patch cords for patch panels. Provide patch cords, as complete assemblies, with matching connectors as specified. Provide fiber optic patch cables with crossover orientation in accordance with TIA-568.3-D.Provide extra patch panel materials equal to 10% of the installed type rounded up.

2.4.5.1 Category 6A Patch Cords

Patch cords shall meet minimum performance requirements specified in TIA-568.1, TIA-568.2 and TIA-568.3 for cables, cable length and hardware specified and shall have the following properties:

A. Shall be round, and consist of 8 insulated 24 AWG stranded copper conductors arranged in 4 color-coded twisted-pairs within flame-retardant jacket.

B. Be equipped with modular 8-position plugs on both ends, wired straight through with standards compliant wiring.

C. Use modular plugs, which exceed FCC CFR 47 Part 68 Subpart F and IEC 60603-7 specifications, and have 50 microinches (0.0013 mm) minimum of gold plating over nickel contacts.

D. Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.

E. Utilize cable that exhibits power sum NEXT performance.

F. Be available in several colors with or without color strain relief boots providing snagless design. Coordinate lengths, quantities, and colors with Minot AFB Installation Communications Squadron (5CS) Project Manager. Required 1 cable per connection in voice/data racks.

G. Meet flex test requirements of 1000 cycles with boots and 100 cycles without boots.

H. Be available in any custom length and standard lengths.

I. Be made by ISO 9001 certified manufacturer.

J. Electrical Specifications:

1. Input Impedance Without Averaging: 100 ohms plus or minus 15 percent from 1 to 100 MHz.
2. One hundred percent transmission tested for performance up to 100 MHz. Manufacturer shall guarantee cords are compatible with Category 6 links.
3. Utilize cable that is UL verified (or equivalent) for TIA/EIA proposed Category 6 electrical performance.
4. UL listed 1863.

2.4.5.2 Modular to 110 Block Patch Panel

Provide in accordance with TIA-568.1 and TIA-568.2. Panels shall be third

party verified and shall comply with EIA/TIA Category 6 requirements. Panel shall be constructed of 0.09 inches minimum aluminum and shall be cabinet or rack mounted and compatible with an ECIA EIA/ECA 310-E 19 inches equipment rack. Panel shall provide 48 non-keyed, 8-pin modular ports, wired to T568A. Patch panels shall terminate the building cabling on Type 110 IDCs and shall utilize a printed circuit board interface. The rear of each panel shall have incoming cable strain-relief and routing guides. Panels shall have each port factory numbered and be equipped with laminated plastic nameplates above each port.

2.4.5.3 Fiber Optic Patch Panel

Provide panel for maintenance and cross-connecting of optical fiber cables. Panel shall be constructed of 16 gauge steel or 11 gauge aluminum minimum and shall be cabinet or rack mounted and compatible with a ECIA EIA/ECA 310-E19 inches equipment rack. Each panel shall provide 12 single-mode or 6 multi-mode and 6 single-mode adapters as duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves, alignment sleeves. Provide dust cover for unused adapters. The rear of each panel shall have a cable management tray a minimum of 8 inches deep with removable cover, incoming cable strain-relief and routing guides. Panels shall have each adapter factory numbered and be equipped with laminated plastic nameplates above each adapter.

Connecting Hardware: Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3. Insertion loss shall not be more than 0.75 dB.

2.4.6 Optical Fiber Patch Cords

A. Available in standard lengths of 3, 6, 10, and 16.4 feet (1, 2, 3, and 5 meters), custom lengths shall also be available, and shall meet or exceed standards as defined in ANSI/TIA/EIA-568 and ISO/IEC 11801.

B. Be either simplex or duplex OFNR riser grade cable, with attenuation at wavelength 1310 nm being 1.0 dB/km and at wavelength 1550 nm 1.0 db/km.

C. Jacket Color: Yellow (OS1 single-mode) or Aqua (OM3 multi-mode).

D. Terminated connectors shall exhibit a maximum insertion loss of 0.50 db with an average of 0.25 dB when tested at either 1310 nm or 1660 nm wavelengths for singlemode fiber.

E. Have average return loss of 53 db with minimum return loss of 40 dB at both 1310 and 1550 nm.

F. Be made by ISO 9002 certified manufacturer.

G. Be UL 1666 approved.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

General Requirements for Cable Connecting Hardware: Comply with TIA-568.2-D, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

Coordinate telecommunications outlet/connector locations with location of

power receptacles at each work area (and ground bars, where applicable).

2.5.1 Outlet/Connector Copper

Outlet/connectors shall comply with FCC Part 68, TIA-568.1, and TIA-568.2. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing and shall be third party verified and shall comply with TIA-568.2 Category 6 requirements. Outlet/connectors provided for UTP cabling shall meet or exceed the requirements for the cable provided. Outlet/connectors shall be terminated using a Type 110 IDC PC board connector, color-coded for both T568A wiring. Each outlet/connector shall be wired T568A. UTP outlet/connectors shall comply with TIA-568.2 for 200 mating cycles. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords. Flush mount jacks, positioning the cord at a 90-degree angle.

2.5.2 Jack Body Color Coding

As identified on sheet TN500.

2.5.3 Optical Fiber Adapters(Couplers)

Provide optical fiber adapters suitable for duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves, as indicated. Provide dust cover for adapters. Optical fiber adapters shall comply with TIA-455-21 for 500 mating cycles.

2.5.4 Optical Fiber Connectors

Provide in accordance with TIA-455-21. Optical fiber connectors shall be duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves, ferrule, epoxyless crimp style compatible with 8/125 single-mode fiber. The connectors shall provide a maximum attenuation of 0.3 dB at 1550 nm with less than a 0.2 dB change after 500 mating cycles.

2.5.5 Cover Plates

Telecommunications cover plates shall comply with UL 514C, and TIA-568.1, TIA-568.2, ; flush design constructed of high-impact thermoplastic or stainless steel material . Provide labeling in accordance with the paragraph LABELING in this section.

2.6 GROUNDING AND BONDING PRODUCTS

Provide in accordance with UL 467, TIA-607, and NFPA 70. Components shall be identified as required by TIA-606. Provide ground rods, bonding conductors, and grounding busbars as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.7 FIRESTOPPING MATERIAL

Provide as specified in Section 07 84 00 FIRESTOPPING.

2.8 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be

acceptable.

2.9 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inches thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inches high normal block style.

2.10 TESTS, INSPECTIONS, AND VERIFICATIONS

2.10.1 Factory Reel Tests

Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with TIA-568.1, TIA-568.2, TIA-568.3, TIA-526-7 for single mode optical fiber cables.

PART 3 EXECUTION

3.1 INSTALLATION

Install telecommunications cabling and pathway systems, including the horizontal and backbone cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware in accordance with NECA/BICSI 568, TIA-568.1, TIA-568.2, TIA-569, NFPA 70, and UL standards as applicable. Provide cabling in a star topology network. Pathways and outlet boxes shall be installed as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install telecommunications cabling with copper media in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling. Cabling shall be run with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment. In the entrance facility, coordinate backbone cabling with the protectors and demarcation point provided by communications service provider (Private ISP service will be by others).

Termination of all 4-pairs from wall-mount 110-type blocks to Telecom rack mount patch panel to permit straight through connection to voice outlet. Wall mounts 100-pair 110-type blocks connection to Telecom rack mount patch panel shall have C4 for first 5 slot and C5 at end of each 25 pair. Wall mounts 100-pair 110-type blocks connection between TRs shall have C5 connector.

3.1.1 Cabling

Install Category 6, UTP, and optical fiber telecommunications cabling system as detailed in TIA-568.1, TIA-568.2, and TIA-568.3. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only

lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four times the cable diameter. Cables shall be terminated; no cable shall contain unterminated elements. Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

Bundle and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use distribution spools.

Terminate all conductors; no cable shall contain unterminated elements except for IDS (panels/system installed by others). Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

Install support bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI TDMM, "Cabling Termination Practices" Chapter.

Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

In the telecommunications rooms, install a 10-foot- (3-m-) long service loop on each end of cable.

Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

3.1.1.1 Separation from EMI Sources

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.1.1.2 Open Cable

Use only where specifically indicated on plans for use in cable trays, or below raised floors. Install in accordance with TIA-568.1, TIA-568.2. Do not exceed cable pull tensions recommended by the manufacturer. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided.

Plenum cable shall be used where open cables are routed through plenum areas. Cable routed exposed under raised floors shall be plenum rated. Plenum cables shall comply with flammability plenum requirements of NFPA 70. Install cabling after the flooring system has been installed in raised floor areas.

3.1.1.3 Backbone Cable

a. Copper Backbone Cable. Install intrabuilding backbone copper cable, in indicated pathways, between the campus distributor, located in the telecommunications entrance facility or room, the building distributors and the floor distributors located in telecommunications rooms and telecommunications equipment rooms as indicated on drawings.

b. Optical fiber Backbone Cable. Install intrabuilding backbone optical fiber in indicated pathways. Do not exceed manufacturer's recommended bending radii and pull tension. Prepare cable for pulling by cutting outer jacket 10 inches leaving strength members exposed for approximately 10 inches. Twist strength members together and attach to pulling eye. Vertical cable support intervals shall be in accordance with manufacturer's recommendations.

3.1.1.4 Horizontal Cabling

Install horizontal cabling as indicated on drawings Do not untwist Category 6 UTP cables more than one half inch from the point of termination to maintain cable geometry. Provide slack cable in the form of a figure eight (not a service loop) on each end of the cable, 10 feet

in the telecommunications room, and 12 inches in the work area outlet.

3.1.2 Pathway Installations

Provide in accordance with TIA-569 and NFPA 70. Install manufactured conduit sweeps and long-radius elbows whenever possible. Conceal raceway and cables except in unfinished spaces. Conceal cables in accessible ceilings, walls, and floors where possible. Provide building pathway as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.3 Pathway Installation in Telecommunications Rooms

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Secure conduits to backboard when entering room from overhead.
3. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.1.4 Service Entrance Conduit, Underground

Provide service entrance underground as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.5 Cable Tray Installation

Install cable tray as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Only CMP and OFNP type cable shall be installed in a plenum.

3.1.6 Work Area Outlets

3.1.6.1 Terminations

Terminate UTP cable in accordance with TIA-568.1, TIA-568.2 and wiring configuration as specified. Terminate fiber optic cables in accordance with TIA-568.3.

3.1.6.2 Cover Plates

As a minimum, each outlet/connector shall be labeled as to its function and a unique number to identify cable link in accordance with the paragraph LABELING in this section.

3.1.6.3 Cables

Unshielded twisted pair and fiber optic cables shall have a minimum of 12 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded.

3.1.6.4 Pull Cords

Pull cords shall be installed in conduit serving telecommunications outlets that do not have cable installed. The pull cords shall be rated at not less than 200-lbs (890 Newton (N)) tensile strength. A minimum of 5 feet (1.5 m) of excess pull cord shall be provided beyond the ends of each conduit.

3.1.7 Telecommunications Space Termination

Install termination hardware required for Category 6 and optical fiber system. An insulation displacement tool shall be used for terminating copper cable to insulation displacement connectors.

3.1.7.1 Connector Blocks

Connector blocks shall be wall mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Install in accordance with industry standard wire routing guides in accordance with TIA-569.

3.1.7.2 Patch Panels

Patch panels shall be mounted in equipment cabinets and racks with sufficient ports to accommodate the installed cable plant plus 25 percent spares.

a. Copper Patch Panel. Copper cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

b. Fiber Optic Patch Panel. Fiber optic cable loop shall be 3 feet in length. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

3.1.7.3 Equipment Support Frames

Install in accordance with TIA-569:

a. Bracket, wall mounted. Mount bracket to plywood backboard in accordance with manufacturer's recommendations. Mount rack so height of highest panel does not exceed 78 inches above floor.

b. Racks, floor mounted modular type. Permanently anchor rack to the floor in accordance with manufacturer's recommendations.

c. Cabinets, freestanding modular type. When cabinets are connected together, remove adjoining side panels for cable routing between cabinets.

d. Cabinets, wall-mounted modular type. Mount cabinet to plywood backboard in accordance with manufacturer's recommendations. Mount cabinet so height of highest panel does not exceed 78 inches above floor.

3.1.8 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 07 84 00 FIRESTOPPING. Likewise, outside plant and backbone conduits emerging from underground shall be sealed.

3.1.9 Grounding and Bonding

Provide in accordance with TIA-607, NFPA 70 and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2 LABELING

3.2.1 Labels

Provide labeling in accordance with TIA-606. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits shall be provided using laser printer . All labels shall be permanent; no hanging or paper tags.

3.2.2 Cable

Cables shall be labeled using color labels on both ends with identifiers in accordance with TIA-606

3.2.3 Termination Hardware

Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with TIA-606. and TN500 series sheets.

Label each terminal strip and screw terminal in each cabinet, rack, or panel. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown. Label each unit and field within distribution racks and frames.

Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware.

Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

Paint and label colors for equipment identification shall comply with TIA-606.

3.3 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.3.1 Painting Backboards

If backboards are required to be painted, then the manufactured fire retardant backboard must be painted with fire retardant paint, so as not to increase flame spread and smoke density and must be appropriately labeled. Label and fire rating stamp must be unpainted.

3.4 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two

sheet-metal screws or two rivets.

3.5 TESTING

3.5.1 Telecommunications Cabling Testing

Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568.1, TIA-568.2, TIA-568.3. Test equipment shall conform to TIA-1152. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.

3.5.1.1 Inspection

Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568A pin assignments, and inspect cabling connections to confirm compliance with TIA-568.1, TIA-568.2, , and TIA-570 for residential cabling. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.

3.5.1.2 Verification Tests

UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but prior to being cross-connected.

UTP Horizontal Cable Performance Tests: For each outlet, perform the following tests according to TIA-568.1 and TIA-568.2:

1. Wire map.
2. Length (physical vs. electrical, and length requirements).
3. Insertion loss.
4. Near-end crosstalk (NEXT) loss.
5. Power sum near-end crosstalk (PSNEXT) loss.
6. Equal-level far-end crosstalk (ELFEXT).
7. Power sum equal-level far-end crosstalk (PSELFEXT).
8. Return loss.
9. Propagation delay.
10. Delay skew.

For optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568.3 and TIA-526-7 using Method B, OTDR for single-mode optical fiber. Perform verification acceptance tests.

Data for each measurement shall be documented. Test results will be maintained in the test manufacturer native format and provided on CD only along with native reader software.

3.5.1.3 Performance Tests

Perform testing for each outlet and MUTOA as follows:

a. Perform Category 6 link tests in accordance with TIA-568.1 and TIA-568.2. Tests shall include wire map, length, insertion loss,

NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.

b. Optical fiber Links. Perform optical fiber end-to-end link tests in accordance with TIA-568.3.

Perform testing for antenna/cable/lightning arrester system using contractor-furnished equipment to demonstrate infrastructure functionality.

3.5.1.4 Final Verification Tests

Perform verification tests for UTP and optical fiber systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

a. Voice Tests. These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and DSN telephone call.

b. Data Tests. These tests assume the Information Technology Staff has a network installed and are available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

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INTERCOMMUNICATION SYSTEM
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(2020) American National Standard Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E	(2005) Cabinets, Racks, Panels, and Associated Equipment

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568.0	(2020e) Generic Telecommunications Cabling for Customer Premises
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2	(2018d) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	(2022e) Optical Fiber Cabling Components Standard

UNIFIED FACILITIES CRITERIA

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.2 RELATED REQUIREMENTS

Section 25 05 11.04 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS applies to this section.

1.3 SYSTEM DESCRIPTION

Provide Data Package 5 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

Provide an Intercommunication System that is solid state, modular in design, and as indicated. Stations must have capacity for later expansion without sacrificing any equipment or feature of performance.

1.3.1 Sound Reproduction

Provide system with normally acceptable speech intelligibility, defined as a score of at least 75 percent obtained utilizing the phonetically balanced monosyllabic work intelligibility test in accordance with ASA S3.2.

Provide an intercommunication system to provide an audio output of no less than 10 dBA above ambient at 3 feet from the surface of each receiving stations over the frequency range of 200 to 5000 Hz, when driven by a sound pressure level at the calling station of at least 70 dBA at the face of the transducer enclosure. All sound pressure levels are referenced to 1 pascal equals 94 dB. The entire system must have a dynamic range of at least 40 dB. The root-mean-square (rms) extraneous noise (e.g. hum) level introduced by the intercommunication system must be at least 30 dB below the nominal signal level. Distortion, including envelope delay, intermodulation, cross talk, and other nonlinear sources, must not exceed 5 percent.

1.3.2 System Operation And Service Features

1.3.2.1 Control and Power Requirements

Provide the system with a power switch and an associated visual indicator for ON and OFF operations. Provide a volume control at each station to regulate listening volume. System must operate on 110-125 Vac , single phase, 60 Hz.

a. Remote stations must utilize Power over Ethernet (PoE). Include all necessary PoE switches, equipment and PoE injectors.

1.3.2.2 Call-In Indication

Master stations must have an audible and visual call-in indicator to provide indication of incoming calls from remote stations. Indication must identify the specific calling station and status, and remain actuated until the call is answered by a master station. Visual call-in indicators must be clearly visible at off-center angles of at least 45 degrees.

1.3.2.3 Identification Plates

In addition to the manufacturer's standard identification plates, provide engraved laminated acrylic plastic identification plates for each component, connection, and terminal. Identification labels must be 3-layered white on black, engraved to show black letters on a white background. Warning and caution labels must be 3-layered white on red,

engraved to show white letters on red background. Control switches and knobs must be clearly marked with their function and status. Identification strips for station selector switches must be located to clearly identify remote and master stations and must be protected by transparent plastic inserts. Lettering must be no smaller than 1/4 inch high, normal block style.

1.3.2.4 Combination Speaker-Handset Stations

At combination speaker-handset stations, lifting the handset must automatically cut out the loudspeaker in the station and all conversation must be carried through the handset.

1.3.2.5 Privacy Switch

Provide privacy switch at each remote station that prevents listening to that station when activated. Activation of the privacy switch must provide a initial temporary audible indication at the master station along with a constant visual indication of the specific station that activated its privacy switch. The visual indication at the master station must only be turned off by resetting the privacy switch at the remote station.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation; G, DO

SD-03 Product Data

All-Call Amplifier; G, DO

Cone-Type Loudspeakers; G, DO

Horn-Type Loudspeakers; G, DO

Intercommunication Amplifier; G, DO

Master Station; G, DO

Remote Audio-Only Station; G, DO

Remote Audio Station; G, DO

Speaker Enclosures; G, DO

Spare Parts; G, RO

SD-06 Test Reports;

Acceptance Tests; G, RO

SD-10 Operation and Maintenance Data

All-Call Amplifier; G, RO

Intercommunication Amplifier; G, RO

Master Station; G, RO

1.4.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.6 EXTRA MATERIALS

After approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy, furnish spare parts data for each different item of equipment and component in the system. Include with the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate equipment that have been in satisfactory use at least 2 years prior to bid opening. Equipment must be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Product Data

Submit Product Data including, but not limited to, capabilities, technical data, operating parameters, operating instructions, and installation instruction for Intercommunication System equipment and components requiring submittals.

2.1.3 Identical Items

Items of the same classification must be identical. This requirement includes equipment, modules, assemblies, parts, and components.

2.1.4 Nameplates

Each major component of equipment must have the manufacturer's name, model number, serial number, and markings for all required code, compliant, and conformant certification on plates mechanically attached to the equipment.

2.1.5 Common Equipment Requirements

2.1.5.1 Intercommunication Amplifier

The system intercommunication amplifier must, as a minimum, conform to the following specifications:

Rated Output Power	10 watts rms minimum
Total Harmonic Distortion	Less than 5 percent at rated output power with a load equivalent to one station connected to output terminals
Signal-To-Noise Ratio	60 dB or greater at rated output
Frequency Response	Plus or minus 3 dB from 150 Hz to 12,000 Hz
Input Sensitivity	Matched to input circuit and providing full-rated output with sound-pressure level of not more than 70 dBA impinging on master stations, speaker microphones, or handset transmitters.

2.1.5.2 All-Call Amplifier

All-call amplifier must, as a minimum, conform to the following specifications:

Rated Output Power	Minimum of 2 watts rms for each station, but no less than 20 watts.
Total Harmonic Distortion	Less than 5 percent at rated output power with a load equivalent to the quantity of stations connected to it in all-call mode of operation
Signal-To-Noise Ratio	60 dB or greater at rated output
Frequency Response	Plus or minus 2 dB from 200 Hz to 10,000 Hz
Output Regulation	Maintains output level within 2dB from full to no load
Input Sensitivity	Compatible with master stations and central equipment so amplifier delivers full-rated output with sound pressure level of less than 0.000145 psi impinging on master station, speaker microphone or hand set transmitter.
External Microphone Input	Balanced low-impedance with switchable 48VDC phantom power
Amplifier Protection	Prevent damage from shorted and open circuits

2.1.5.3 Power Line Surge Protection

Provide a permanently-mounted (not a portable power strip) UL 1449 Type 3 Listed Surge Protective Device for all amplifiers. The surge protector

must have a Maximum Continuous Operating Voltage of 150 volts for 120 VAC supply voltage and 300 volts for a 230 or 240 VAC supply voltage. The maximum Voltage Protection Rating must not exceed 600 VAC line-to-neutral, 700 VAC line-to-ground, and 600 VAC neutral-to-ground for a 120 VAC supply voltage or 1200 VAC line-to-neutral, 1500 VAC line-to-ground, and 1200 VAC neutral-to-ground for a 230 or 240 VAC supply voltage. Surge protection device must be UL listed and labeled as having been tested in accordance with UL 1449, 4th Edition.

2.1.5.4 Signal Circuit Protection

All amplifiers must have internal protection circuits that protect the internal components from mismatched loads, direct current and shorted output lines. Communication conductors must have surge protection installed at each point where it exits or enters a building.

2.1.5.5 Remote Audio-Only Station

Ceiling-mounted remote station must have stainless steel faceplate with tamper proof mounting screws and galvanized steel backbox. The remote station must have:

a. A speaker with a minimum sensitivity of 90 dB on axis at 4 feet from the speaker when driven at one watt rms.

b. A call announcement visual indicator that illuminates when there are incoming calls. Visual announcement indicators must be clearly visible at off-center angles of at least 45 degrees.

c. A recurring momentary tone that announces incoming calls.

d. Call Switch that permits a call to the master station.

e. Provide a privacy switch at each remote station. When in the ON position, the switch must prevent any transmission of sound from the remote station. When in the OFF position, persons must be able to respond to incoming call without manual intervention.

g. NEMA 4X IP66 rating.

2.1.5.6 Remote Audio Station

Wall-mounted remote station must have stainless steel faceplate with tamper proof mounting screws and galvanized steel backbox. The remote audio-video station must have the following features:

a. A speaker with a minimum sensitivity of 90 dB on axis at 4 feet from the speaker when driven at one watt rms.

b. A call announcement indicator that illuminates when there are incoming calls. Visual announcement indicators must be clearly visible at off-center angles of at least 45 degrees.

c. A recurring momentary tone that announces incoming calls.

d. Call Switch that permits a call to the master station.

e. A fixed-focal length, recessed color camera with the following features:

(1) Sufficient depth of field to provide clear images with no discernable difference in sharpness for subjects between 12 inches to 84 inches from the camera lens surface.

(2) An angle of view between 80 and 115 degrees.

(3) Resolution of at least one megapixel.

(4) Full color video when the vertical illumination on the subject's face is as low as 2 footcandles.

(5) Effective frame rate of at least 20 frames per second.

(6) Dynamic range of at least 100 to 1.

(7) H.264 or H.265 compressed video output.

(8) Integral white LED to illuminate subject to maintain above specifications when ambient light level is below 2 footcandles.

(9) Scratch-resistant multicoated clear or neutral-tinted optical cover.

(10) Operating temperature of minus 20 to plus 130 degrees Fahrenheit with no discernable loss of performance.

(11) Operation over IPv4 and IPv6 network protocol.

(12) NEMA 4X IP66 rating.

2.1.5.7 Cone-Type Loudspeakers

Cone-type loud speakers, not integral with a remote station, must be enclosed in a steel housing and must be acoustically dampened with a front face of at least 0.0478 inches steel. The whole assembly must be rust proofed and factory primed complete with mounting assembly. Baffle for flush speakers must be a minimum thickness of 0.032 inches aluminum brushed to a satin sheen and lacquered . Vandal-proof high strength baffles for flush mounted speakers must be cast aluminum with tensile strength of 44,000 psi and a minimum thickness of 0.025 inch. The mounting screws must be heat-treated alloy. The cone-type loudspeakers must comply with the following specifications:

Axial Sensitivity	Minimum of 90 dB with one watt input measured at 4 feet
Frequency Response	Within plus or minus 6 dB from 70 to 15,000 Hz
Minimum Power Rating	8 watts
Minimum Dispersion Angle	100 degrees
Line Transformers Power Rating	At least 4 watts with at least four taps with insertion loss of no more than 0.5 dB

Speaker Size	8 inches with 1 inch voice coil and minimum 5 oz ceramic magnet
Speaker Cone	Resistant to fracture and delamination.
Speaker Cone Surround	Provide sealer on cone surround to minimize environmental effects and aging degradation.

2.1.5.8 Horn-Type Loudspeakers

Horn-type loudspeakers must be all metal construction complete with universal mounting brackets.. The horn type loudspeakers must be provided with an internally mounted, factory installed line transformers and must as a minimum conform to the following specifications:

Minimum Power Rating	25 watts
Horizontal Dispersion Angle	90
Vertical Dispersion Angle	57
Axial Sensitivity	Minimum of 110 dB with one watt input measured at 4 feet
Line Transformers Power Rating	At least 4 watts with at least four taps with insertion rate of 0.5 dB

2.1.5.9 Master Station Capacity

Master Stations and associated equipment, regardless of system type, must have an as-installed spare capacity of at least 25 percent to allow this amount of remote stations to be added without additional system, software, or hardware additions or modifications except for the added remote stations and their connection to their immediate upstream device.

2.2 TYPE 1 SYSTEM

A manually switched direct connected keyed intercommunication system that must accommodate at least 4 remote stations. Remote stations must be provided in the quantities indicated. The master station must selectively communicate with any remote station by actuation of an appropriate selector switch. The master station must be capable of initiating a message to all remote stations simultaneously or in groups of not less than 10 stations per group.

2.2.1 Master Station

Surface wall -mounted master stations must have:

a. Station-selector switches and talk-listen switches with heavy duty type gold plated contacts rated for at least five million operations.

b. Volume Control to regulate incoming call volume.

c. A light annunciation that identifies the calling stations and stations in use. The light must remain on until the call is answered.

d. A tone annunciator with a momentary audible tone signal that announces incoming calls.

f. A lockable, ventilated metallic central control cabinet complying with ECIA EIA/ECA 310-E. The cabinet must house terminal strips, power supplies, amplifiers, system volume control, and auxiliary equipment.

2.3 SPEAKER ENCLOSURES

Speaker enclosures must be compatible with the speakers specified and comply with UL 50.

2.4 TERMINALS

Terminals must be solderless, tool-crimped pressure type.

2.5 COMMUNICATIONS WIRING

Type of signal and control circuit wire and number of conductors must be provided as recommended by the intercommunication system manufacturer, and as necessary to provide a complete and operable system. Where required, cable must be UL classified low smoke and low flame for use in air plenums in accordance with NFPA 70.

a. Unless manufacturer, voltage drop, or attenuation requirements are more stringent, multi-conductor cables not used with modular connectors must contain only stranded conductors of minimum 22 AWG gauge, insulated with minimum 105-degree Celsius-rated insulation. Cable jacket must be rated at minimum of 105 degrees Celsius.

b. Balanced twisted-pair telecommunications cables must be rated as above, except that conductors must be minimum 24 AWG; cables including modular connectors must be rated at least Category 5e .

c. Comply with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM when utilizing IP-based systems.

2.6 SURGE PROTECTION

Major components of the system such as Master Stations, Amplifiers, and Remote Stations, must have devices, either internal or external, that must provide protection against voltage spikes and current surges.

a. Signal, Data, and low-voltage power: Continuous voltage rating of surge protective devices internal to the units must be between 120 and 140 percent of the nominal circuit voltage, maximum leakage current must be less than one milliampere, and the unit must be able to absorb at least one hundred 1,000-ampere 8x 20 microsecond pulses without appreciable degradation.

b. External surge protective devices for incoming AC line-voltage protection must be UL 1449-listed Type 3 with a maximum Voltage Protective Rating (VPR) of 330 volts for nominal line voltages of 120 VAC and a VPR of 600 volts for nominal line voltages above 120 volts when tested in accordance with UL 1449.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with the details of the work and working conditions, verify locations and dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work.

3.2 INSTALLATION

Install all system components and appurtenances in accordance with the manufacturer's instructions and as specified and shown. Units to be mounted outside or subject to inclement conditions must be weatherproof or be mounted in weatherproof enclosures.

3.2.1 Signal and Control Circuits Wiring

Install signal and control circuits in accordance with NFPA 70, TIA-568.0, TIA-568.1, TIA-568.2, TIA-568.3, and as indicated. The conductors must be separated as recommended by the equipment manufacturer.

a. Size conductors to maintain voltage drop in power circuits to no more than 3-percent and loss in signal circuits to no more than 0.5 dB. Comply with Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM for IP-based systems. Include boosters, additional power supplies, amplifiers, switches, etc. as necessary to maintain these requirements.

b. Run conductors and cables from unit to unit without splicing.

c. Cables that do not use modular connectors can use terminal strips and junction boxes to extend the cable if in conformity with manufacturer recommendations.

d. Provide data switches to extend cable length as necessary for IP-based systems when cable run would otherwise exceed requirements.

e. Follow applicable portions of Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM when utilizing IP-based systems.

f. Locate switches and other consolidation points in Telecommunications Rooms.

3.2.2 Conduit, Cable Tray and Tubing Systems

Install wiring in rigid conduit, intermediate metal conduits, cable trays, or electric metallic tubing as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.3 WARRANTY

Provide a 5 -year warranty for all units, parts,and assemblies and a 2 -year warranty on all labor. Include travel and expense costs associated with repair and supervisory persons such that owner is not charged for these when warranty labor is provided.

3.4 GROUNDING

Perform the connection of interfacing components through the use of

transformers and the tying of interconnecting lines to a unit ground bus at one end only.

3.5 TRAINING

Conduct a training course for two members of the operating staff and for two members of the maintenance staff as designated by the Contracting Officer. The training course must be given at the installation during normal working hours for a total of 2 hours for the operating staff and 4 hours for the maintenance staff, and must start after the system is functionally complete but prior to final acceptance tests. The field instructions must cover all of the items contained in the approved operating and maintenance instructions, as well as the demonstration of routine maintenance operations. Notify the Contracting Officer at least 14 days prior to the start of the training course.

3.6 ACCEPTANCE TESTS

After installation has been completed, conduct an acceptance test, using the approved test plan, to demonstrate that the equipment operates in accordance with specification requirements. Submit test plan and procedures for the acceptance test explaining in detail step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedures must also explain methods for simulating the necessary conditions of operation to demonstrate system performance. Notify the Contracting Officer 14 days prior to the performance of tests. In no case must notice be given until after the written approval of the test plans. The acceptance tests must include as a minimum the following tests:

3.6.1 Operational Test

Test originating station-to-station, and all call at each intercommunication station. Verify proper routing and volume levels and that the system is free of noise and distortion. Test available message path from each station on system.

3.6.2 Frequency Response Test

Determine frequency response of two transmission paths, including all-call, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.

3.6.3 Signal-to-Noise Ratio Test

Measure signal-to-noise ratio of complete system at normal gain setting as follows:

a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000 Hz signal. Measure signal-to-noise ratio at intercom station speakers.

b. Repeat test for 10-percent of the speaker microphones, but no less than one speaker-microphone.

c. Minimum acceptable ratio is 35 dB.

3.6.4 Distortion Test

Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each all-call amplifier, and a minimum of two selected intercommunication amplifiers. For each frequency, measure distortion in the all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.

3.6.5 Video Tests

Verify that video from all remote stations appears at all master stations with proper resolution, focus, and color balance meeting the manufacturer's published specifications.

3.6.6 Test Reports

Submit test reports in booklet form, upon completion and testing of the installed system, showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria. Include in each test report the final position of controls and operating mode of the system. Include the manufacturer, model number, and serial number of test equipment used in each test.

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SECTION 28 31 70

INTERIOR FIRE ALARM SYSTEM, ADDRESSABLE
08/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide https://www.approvalg

INTERNATIONAL CODE COUNCIL (ICC)

IFC	(2018) International Fire Code
IMC	(2018) International Mechanical Code

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 4	(2018) Standard for Integrated Fire Protection and Life Safety System Testing
NFPA 20	(2022) Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 69	(2019) Standard on Explosion Prevention Systems
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 170	(2021) Standard for Fire Safety and Emergency Symbols
NFPA 720	(2015) Standard for the Installation of

	Carbon Monoxide (CO) Detection and Warning Equipment

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-520-01	(2015; with Change 2, 2021) Interior Electrical Systems
UFC 3-600-01	(2016; with Change 6, 2021) Fire Protection Engineering for Facilities
UFC 3-601-02	(2021) Fire Protection Systems Inspection, Testing, and Maintenance
UFC 4-010-06	(2016; with Change 1, 2017) Cybersecurity of Facility-Related Control Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices
47 CFR 90	Private Land Mobile Radio Services

UL SOLUTIONS (UL)

UL 268	(2023) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; Reprint Oct 2014) Smoke Detectors for Duct Application
UL 464	(2023) UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
UL 497A	(2001; Bul. 2019) UL Standard for Safety Secondary Protectors for Communications Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 864	(2023) UL Standard for Safety Control Units and Accessories for Fire Alarm Systems
UL 1283	(2017; Reprint Feb 2024) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL 1480	(2023) UL Standard for Safety Speakers for Fire Alarm and Signaling Systems, Including Accessories
UL 1638	(2023) UL Standard for Safety Visible Signaling Devices for Fire Alarm and

	Signaling Systems, Including Accessories
UL 1971	(2002; Reprint Feb 2024) UL Standard for Safety Signaling Devices for the Deaf and Hard of Hearing
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 RELATED SECTIONS

Section 25 05 11.03 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - FIRE ALARM, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

Section 08 71 00 DOOR HARDWARE
Section 21 13 13 WET PIPE SPRINKLER SYSTEMS, FIRE PROTECTION
Section 21 13 18 PREACTION SPRINKLER SYSTEMS, FIRE PROTECTION
Section 21 30 00 FIRE PUMPS
Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC
Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
Section 23 30 00 HVAC AIR DISTRIBUTION
Section 25 05 11.01 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - HVAC
Section 25 05 11.02 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - FUEL CONTROL
Section 25 05 11.03 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - FIRE ALARM
Section 25 05 11.04 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - INTERCOM/PUBLIC ADDRESS
Section 25 05 11.05 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS - GENERATOR/SWITCHGEAR SCADA
Section 26 20 00 PANELBOARDS and EP series sheets for shunt trip operation of circuit breakers.
Section 26 51 00 INTERIOR LIGHTING and EL series sheets for additional work related to egress lighting activation override.
Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM
Section 27 51 23 INTERCOMMUNICATION SYSTEM
Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS

1.3 SUMMARY

1.3.1 Scope

a. This work includes designing and providing a new, complete, fire alarm system as described herein and on the contract drawings. Include system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, initiating devices, notification appliances, supervising station fire alarm transmitters, and other accessories and miscellaneous items required for a complete operational system even though each item is not specifically mentioned or described. Provide systems complete and ready for operation. Design and installation must comply with the drawings and this section, UFC 3-600-01, NFPA 20, NFPA 72, Section 25 05 11.03, UFC 4-010-06 and AFGM 2019-320-02.

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with NFPA 72, except as modified herein. The system layout on the drawings show the intent of coverage

and suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor.

c. Each remote fire alarm control unit must be powered from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the remote fire alarm control unit. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units. The "local emergency power panel" (also termed "Dedicated Emergency Panel Schedules" in the contract documents) for this building is designated as Panel NL3.

d. Where a fire pump(s) is(are) provided, the fire alarm system must monitor and transmit the fire pump controller signals in accordance with the provisions of NFPA 72.

e. The fire alarm system must be independent of the building security, building management, and energy/utility monitoring systems other than for control functions.

1.3.2 Qualified Fire Protection Engineer (QFPE)

Services of the QFPE must include:

a. Reviewing SD-02, SD-03, and SD-05 submittal packages for completeness and compliance with the provisions of this specification. Construction (shop) drawings and calculations must be prepared by, or prepared under the immediate supervision of, the QFPE. The QFPE must affix their professional engineering stamp with signature to the shop drawings, calculations, and material data sheets, indicating approval prior to submitting the shop drawings to the DFPE.

b. Providing a letter documenting that the SD-02, SD-03, and SD-05 submittal package has been reviewed and noting any outstanding comments.

c. Performing in-progress construction surveillance prior to installation of ceilings (rough-in inspection).

d. Witnessing pre-Government and final Government functional performance testing and performing a final installation review.

e. Signing applicable certificates under SD-07.

The submittal requirement for the Qualified Fire Protection Engineer (QFPE) is found in this Section applies to all Sections in which the requirement for Qualified Fire Protection Engineer (QFPE) is present.

1.4 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions must be defined as follows:

1.4.1 Interface Device

An addressable device which interconnects hard wired systems or devices to an analog/addressable system.

1.4.2 Fire Alarm Control Unit (FACU)

A master control unit having the features of a fire alarm control unit (FACU).

1.4.3 Remote Fire Alarm Control Unit

A control unit, physically remote from the fire alarm control unit, which receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm and mass notification control unit.

1.4.4 Terminal Cabinet

A steel cabinet with locking, hinge-mounted door where terminal strips are securely mounted inside the cabinet.

1.4.5 Control Module and Relay Module

Terms utilized to describe emergency control function interface devices as defined by NFPA 72.

1.4.6 Designated Fire Protection Engineer (DFPE)

The DoD fire protection engineer who oversees the Area of Responsibility for that project. This is sometimes referred to as the "cognizant" fire protection engineer. Interpret reference to "authority having jurisdiction" and/or AHJ in referenced standards to mean the Designated Fire Protection Engineer (DFPE). The DFPE may be responsible for review of the contractor submittals having a "G" designation, and for witnessing final inspection and testing.

1.4.7 Qualified Fire Protection Engineer (QFPE)

A QFPE is an individual who is a licensed professional engineer (P.E.), who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveying (NCEES) and has relevant fire protection engineering experience.

1.5 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

All submittals shall be stamped and sealed by the contractor's QFPE. See section on QFPE qualifications.

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.

Shop drawings (SD-02), product data (SD-03) and calculations (SD-05) must be prepared by the fire alarm designer and combined and submitted as one complete package. The QFPE must review the SD-02/SD-03/SD-05 submittal

package for completeness and compliance with the Contract provisions prior to submission to the Government. The QFPE must provide a Letter of Confirmation that they have reviewed the submittal package for compliance with the contract provisions. This letter must include their registered professional engineer stamp and signature. Partial submittals and submittals not reviewed by the QFPE will be returned by the Government disapproved without review.

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualified Fire Protection Engineer (QFPE); G, DO

Fire alarm system designer; G, DO

Supervisor; G, DO

Technician; G, DO

Installer; G, DO

Test Technician; G, DO

Fire Alarm System Site-Specific Software Acknowledgement; G, DO

SD-02 Shop Drawings

Shop drawings shall not be smaller than the Contract Drawings. Submit plan view drawing showing device locations, device addresses, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Drawings shall comply with the requirements of NFPA 72 and NFPA 170.

Nameplates; G, RO

Instructions; G, RO

Wiring Diagrams; G, DO

System Layout; G, DO

Notification Appliances; G, DO

Initiating devices; G, DO

Battery Power (Other than RSCP); G, DO

Voltage Drop Calculations (Other than RSCP); G, DO

Dedicated Emergency Panel Schedules; G, DO

SD-03 Product Data

Fire Alarm Control Unit (FACU); G, DO

LCD Annunciator; G, DO

Manual Stations; G, DO

Smoke Detectors; G, DO

Duct Smoke Detectors; G, DO

Addressable Interface Devices; G, DO

Addressable Control Modules; G, DO

Isolation Modules; G, DO

Notification Appliances; G, DO

Batteries; G, DO

Battery Chargers; G, DO

Supplemental Notification Appliance Circuit Panels; G, DO

Level Sensor; G, DO

Auxiliary Power Supply Panels; G, DO

Surge Protective Devices; G, DO

Alarm Wiring; G, DO

Back Boxes and Conduit; G, DO

Ceiling Bridges for Ceiling-Mounted Appliances; G, DO

Terminal Cabinets; G, DO

Automatic Fire Alarm Transmitters (including housing); G, DO

Radio Transmitter and Interface Panels; G, DO

Environmental Enclosures or Guards; G, DO

Hydrogen Detectors; G, DO

Carbon Monoxide Detectors; G, DO

Low Temperature Sensors; G, DO

Solenoid Disconnect Switches; G, DO

Pressure Switches; G, DO

Spare Parts; G, DO

Equipment List; G, DO

SD-06 Test Reports

Test Procedures; G, RO

Smoke Sensor Testing; G, RO

SD-07 Certificates

Verification of Compliant Installation; G, RO

Request for Government Final Test; G, RO

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G, RO

Instruction of Government Employees; G, RO

Training Documentation; G, RO

SD-11 Closeout Submittals

As-Built Drawings

Document Storage Cabinet

Spare Parts

1.5.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.6 SYSTEM OPERATION

Fire alarm system components requiring power, except for the FACU(s) and RSCP(s) power supplies, must operate on 24 volts DC unless noted otherwise in this section.

The interior fire alarm system must be a complete, supervised, noncoded, analog/addressable fire alarm system conforming to NFPA 20, NFPA 72, and UL 864. Systems meeting UL 2017 only are not acceptable. The system must be activated into the alarm mode by actuation of an alarm initiating device. The system must remain in the alarm mode until the initiating device is reset and the control unit is reset and restored to normal.

The fire alarm system interfaces with the Releasing Service Fire Alarm Control Panel (RSCP), for which requirements are found in Section 21 13 18 and with which the fire alarm system installation must coordinate.

1.6.1 Alarm Initiating Devices and Notification Appliances (Visual, Audible)

a. Connect alarm initiating devices to initiating device circuits (IDC) Class "A", or to signaling line circuits (SLC) Class "A" and installed in accordance with NFPA 72, including IDC and SLC circuits for the RSCP(s).

b. Connect notification appliances to notification appliance circuits (NAC) Class "A".

1.6.2 Functions and Operating Features

The system must provide the following functions and operating features:

a. Power, annunciation, supervision, and control for the system. Addressable systems must be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

b. Visual alarm notification appliances must be synchronized as required by NFPA 72.

c. Electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control unit.

d. An audible and visual trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal must also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory control unit modules. After the system returns to normal operating conditions, the trouble signal must again sound until the trouble is acknowledged. A smoke detector in the process of being verified for the actual presence of smoke must not initiate a trouble condition.

e. A trouble signal silence feature that must silence the audible trouble signal, without affecting the visual indicator.

f. Program capability via switches in a locked portion of the FACU to bypass the automatic notification appliance circuits, fire reporting system features. Operation of this programmed action must indicate on the FACU display as a supervisory or trouble condition.

g. Alarm functions must override trouble or supervisory functions. Supervisory functions must override trouble functions.

h. The system must be capable of being programmed from the control unit keyboard. Programmed information must be stored in non-volatile memory.

i. The system must be capable of operating, supervising, and/or monitoring non-addressable alarm and supervisory devices.

j. There must be no limit, other than maximum system capacity, as to the number of addressable devices that may be in alarm simultaneously.

k. Where the fire alarm system is responsible for initiating an action in another emergency control device or system, such as HVAC or lighting, the addressable fire alarm relay must be located in the vicinity of the emergency control device.

l. An alarm signal must automatically initiate the following functions (in addition to the functions identified on the control matrices):

(1) Transmission of an alarm signal to the fire department.

(2) Visual indication of the device operated on the FACU and RSCP, and on the graphic annunciator.

(4) Actuation of alarm notification appliances.

(5) Recording of the event electronically in the history log of the FACU.

(6) Select actions also report to the building DDC system.

m. A supervisory signal must automatically initiate the following functions (in addition to the functions identified on the control matrices):

(1) Visual indication of the device operated on the FACU or RSCP (as assigned by functional matrix), and on the graphic annunciator.

(3) Transmission of a supervisory signal to the fire department.

(4) Operation of a duct smoke detector must shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph and as allowed by NFPA 72.

(5) Recording of the event electronically in the history log of the FACU.

(6) Select actions also report to the building DDC system.

n. A trouble condition must automatically initiate the following functions (in addition to the functions identified on the control matrices):

(1) Visual indication of the device operated on the FACU or RSCP (as assigned by functional matrix), and on the graphic annunciator.

(3) Transmission of a trouble signal to the fire department.

(4) Recording of the event electronically in the history log of the FACU.

o. Activation of a carbon monoxide alarm initiating device must automatically initiate the following functions:

(1) Visual indication of the device operated on the , LCD, LED Display unit (VDU), and on the remote annunciator. Indication on the graphic annunciator must be by floor and room number, device address, and device type.

(2) Transmission of a carbon monoxide alarm signal to a remote supervising station.

(3) Activation of all strobes and the carbon monoxide alarm signal throughout the building.

(4) Recording of the event electronically in the history log of the FACU.(5) Select actions also report to the building DDC system.

p. System control equipment must be programmed to provide a 60-minute to 180-minute delay in transmission of trouble signals resulting from primary power failure.

q. Provide signaling line circuits for the network.

r. Provide notification appliance circuits. The visual alarm notification appliances shall have the flash rates synchronized as required by NFPA 72.

s. Silencing.

(1) Subsequent actuation of other initiating devices or supervisory signals after the initial alarm or supervisory signal has been silenced shall cause the notification appliances to reactivate.

(2) If an audible trouble signal has been silenced, it shall comply with the following:
(i) The audible trouble shall re-sound every 24 hours or less until fault conditions are restored to normal.
(ii) The re-sound audible trouble signal shall sound until it is manually silenced or acknowledged.
(iii) The re-sounded audible trouble signal shall also be automatically re-transmitted to the base fire department.

(3) When the silence switch is left in the active position and there is no alarm, supervisory, or trouble signal, an audible trouble signal and a visual indicator shall be activated until the switch is restored to its normal position.

Report supervisory alarms as independent addresses to the FACP, RSCP, or Energy Management Control System as indicated on the functional matrixes. Grouped switches on common addresses are not permitted. Provide non-latching electronically supervisory devices unless otherwise indicated.

Alarm signals, supervisory signals, and trouble signals shall be clearly differentiated at the control panels and annunciators.

1.7 TECHNICAL DATA AND SITE-SPECIFIC SOFTWARE

Technical data and site-specific software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be required in other specifications, must be delivered, strictly in accordance with the CONTRACT CLAUSES. The fire alarm system manufacturer must submit written confirmation of this contract provision as "Fire Alarm System Site-Specific Software Acknowledgement". Identify data delivered by reference to the specification paragraph against which it is furnished. Data to be submitted must include complete system, equipment, and software descriptions. Descriptions must show how the equipment will operate as a system to meet the performance requirements of this contract. The site-specific software data package must also include the following:

a. Items identified in NFPA 72, titled "Site-Specific Software".

b. Identification of programmable portions of the system equipment and capabilities.

c. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

d. Provision of operational software data on all modes of programmable portions for fire alarm .

e. Description of Fire Alarm Control Unit equipment operation.

f. Description of auxiliary and remote equipment operations.

g. Library of application software.

h. Operation and maintenance manuals.

1.8 QUALITY ASSURANCE

1.8.1 Submittal Documents

1.8.1.1 Preconstruction Submittals

Within 36 days of contract award but not less than 14 days prior to commencing any work on site, the Contractor must submit the following for review and approval. SD-02, SD-03 and SD-05 submittals received prior to the review and approval of the qualifications of the fire alarm subcontractor and QFPE must be returned disapproved without review. All resultant delays must be the sole responsibility of the Contractor.

1.8.1.2 Nameplates

Nameplate illustrations and data to obtain approval by the Contracting Officer before installation.

1.8.1.3 Wiring Diagrams

Copies of point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems which are supervised or controlled by the system. Diagrams must show connections from field devices to the FACU and remote FACU, initiating circuits, switches, relays and terminals, including pathway diagrams between the control unit and shared communications equipment within the protected premises. Point-to-point wiring diagrams must be job specific and must not indicate connections or circuits not being utilized. Provide complete riser diagrams indicating the wiring sequence of all devices and their connections to the control equipment. Include a color-code schedule for the wiring.

Provide a schedule of connections for the fire alarm, intercom/public address, releasing service, HVAC system, power system, and any other connected systems and all associated interfaces.

1.8.1.4 System Layout

Copies of plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, conduit sizes, wire counts, conduit fill calculations, wire color-coding, circuit identification in each conduit, and circuit layouts for all floors, control equipment, alarm and supervisory signal initiating devices, alarm notification appliances, supervising station fire alarm system

transmitter, and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide systems complete and ready for operation.. Indicate candela rating of each visual notification appliance and wattage and decibel rating of each audible notification appliance. Clearly identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, etc. Clearly identify the locations of isolation modules. Indicate the addresses of all devices, modules, relays, and similar. Indicate if the environment for the FACU is within its environmental listing (e.g. temperature/humidity).

Provide a complete description of the system operation in matrix format capturing the items identified in the (and of formatting similar to the) Functional Matrices and the requirements of the related specification sections listed herein.

1.8.1.5 Notification Appliances

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances. Annotate data for each circuit on the drawings.

1.8.1.6 Initiating Devices

Calculations and supporting data on each circuit to indicate that there is at least 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

1.8.1.7 Battery Power (Other than RSCP)

Calculations and supporting data as required in paragraph Battery Power Calculations for alarm, alert, and supervisory power requirements. Calculations including ampere-hour requirements for each system component and each control unit component, and the battery recharging period, must be included on the drawings.

Calculations for work associated with the releasing service control panel are in Section 21 13 18.

1.8.1.8 Voltage Drop Calculations (Other than RSCP)

Voltage drop calculations for all circuits indicating sufficient voltage is available for proper operation of the system and all components, at a minimum rated voltage of the system operating on batteries. Identify on device data and calculations the minimum operable voltage per manufacturer recommendations for all devices requiring power, and identify special device features to be used where the delivered voltage does not satisfy the manufacturer's standard voltage range. Include the calculations on the system layout drawings.

Calculations for work associated with the releasing service control panel are in Section 21 13 18.

1.8.1.9 Product Data

Provide annotated descriptive data to show the specific model, type, and size of each item. Catalog cuts must also indicate the NRTL listing. The data must be highlighted to show model, size, and options that are intended for consideration. Data must be adequate to demonstrate

compliance with all contract requirements. Product data for all equipment must be combined into a single submittal.

Provide an equipment list identifying the type, quantity, make, and model number of each piece of equipment to be provided under this submittal. The equipment list must include the type, quantity, make and model of spare equipment. Types and quantities of equipment submitted must coincide with the types and quantities of equipment used in the battery calculations and those shown on the shop drawings.

1.8.1.10 Operation and Maintenance (O&M) Instructions

Six copies of the Operation and Maintenance Instructions, indexed and in booklet form and a PDF on CD/DVD. The O&M Instructions must be prepared in a single volume or in multiple volumes, with each volume indexed, and may be submitted as a Technical Data Package. Manuals must be approved prior to training. The Interior Fire Alarm System Operation and Maintenance Instructions must include the following:

a. "Manufacturer Data Package five" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual must include the manufacturer's name, model number, service manual, parts list, and preliminary equipment list complete with description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals must include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. Complete procedures for system revision and expansion, detailing both equipment and software requirements.

e. Software delivered for this project shall be provided, on each type of CD/DVD media utilized.

f. Printouts of configuration settings for all devices.

g. Routine maintenance checklist. The routine maintenance checklist must be arranged in a columnar format. The first column must list all installed devices, the second column must state the maintenance activity or state no maintenance required, the third column must state the frequency of the maintenance activity, and the fourth column provided for additional comments or reference. All data (devices, testing frequencies, and similar) must comply with UFC 3-601-02.

h. A final Equipment List must be submitted with the Operating and Maintenance (O&M) manual.

1.8.1.11 As-Built Drawings

The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of the as-built (marked-up) drawings must be provided at the time of, or prior to the final Government test.

1.8.2 Qualifications

1.8.2.1 Fire Alarm System Designer

The fire alarm system designer must be certified as a Level IV (minimum) Technician by National Institute for Certification in Engineering Technologies (NICET) in the Fire Alarm Systems subfield of Fire Protection Engineering Technology or meet the qualifications for a QFPE.

1.8.2.2 Supervisor

A NICET Level IV fire alarm technician must supervise the installation of the fire alarm system. The fire alarm technicians supervising the installation of equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.3 Technician

Fire alarm technicians with a minimum of four years of experience must be utilized to install and terminate fire alarm devices, cabinets and control units. The fire alarm technicians installing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings, and must be thoroughly experienced in the installation of air sampling detection systems.

1.8.2.4 Installer

NICET Level II technician to assist in the installation of fire alarm devices, cabinets and control units. A licensed electrician must be allowed to install wire, cable, conduit and backboxes for the fire alarm system system. The fire alarm installer must be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.8.2.5 Test Technician

Fire alarm technicians with a minimum of eight years of experience and NICET Level IVutilized in testing and certification of the installation of the fire alarm devices, cabinets and control units. The fire alarm technicians testing the equipment must be factory trained in the installation, adjustment, testing, and operation of the equipment installed as part of this project.

1.8.2.6 Manufacturer

Components must be of current design and must be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as specified herein.

1.8.3 Regulatory Requirements

Equipment and material must be listed or approved. Listed or approved, as used in this Section, means listed, labeled or approved by a Nationally Recognized Testing Laboratory (NRTL) such as UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described must not be construed as waiving this

requirement. All listings or approvals by testing laboratories must be from an existing ANSI or UL published standard. The recommended practices stated in the manufacturer's literature or documentation must be considered as mandatory requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.10 MAINTENANCE

1.10.1 Spare Parts

Furnish the following spare parts in the manufacturers original unopened containers:

a. Five complete sets of system keys.

b. Two of each type of fuse required by the system.

c. One manual stations.

d. Two of each type of detector installed.

e. Two of each type of detector base and head installed.

g. One smoke detector manufacturer's test screen, card or magnet for each ten beam smoke detectors, or fraction thereof, installed in the system.

i. Two of each type of audible and visual alarm device installed.

l. Two low voltage, one telephone, and one 120 VAC surge protective device.

1.10.2 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment must be furnished to the Contracting Officer, prior to the instruction of Government employees.

PART 2 PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENT

All fire alarm equipment must be listed for use under the applicable reference standards.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory and listed for fire protection service when so required by NFPA 72 or this specification. Select

material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment must be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening.

2.2.2 Nameplates

Major components of equipment must have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new name plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FACU

b. Automatic transmitter/transceiver

c. Terminal Cabinet

d. RSCP

e. Fire Alarm Annunciators

f. Fire Pump Controllers

f. Diesel Fire Pump Remote Annunciators

Nameplates must be etched metal or plastic, permanently attached by screws to control units or adjacent walls.

2.2.3 Keys

Keys and locks for equipment, control units and devices must be identical. Provide note less than six keys of each type required. Master all keys and locks to a single key as required by the Installation Fire Department.

2.2.4 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the instructions on the interior of the FACU. The card must show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions and their mounting location must be approved by the Contracting Officer before being posted.

2.3 FIRE ALARM CONTROL UNIT

This contract shall use as a sole source EST Fire Alarm Control System and compatible devices per the Department of the Air Force Fire Alarm Panel Standardization Memorandum dated 19May2023.

Provide a complete fire alarm control unit (FACU) fully enclosed in a lockable steel cabinet as specified herein. Operations required for testing or for normal care, maintenance, and use of the system must be performed from the front of the enclosure. If more than a single unit is

required at a location to form a complete control unit, the unit cabinets must match exactly. The system must be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, relays for output function actuation.

a. Each control unit must provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit must be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each control unit with supervisory functions for power failure, internal component placement, and operation.

b. Visual indication of alarm, supervisory, or trouble initiation on the FACU must be by liquid crystal display or similar means with a minimum of 80 characters.

2.3.1 Cabinet

Install control unit components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface or semi-recessed mounting provisions. The enclosure must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must say "Fire Alarm control unit" and must not be less than 1-inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches.

2.3.2 Silencing Switches

2.3.2.1 Alarm Silencing Switch

Provide an alarm silencing switch at the FACU that must silence the audible and visual notification appliances. Subsequent activation of initiating devices must cause the notification appliances to re-activate.

2.3.2.2 Supervisory/Trouble Silencing Switch

Provide supervisory and trouble silencing switch(es) that must silence the audible trouble and supervisory signal(s), but not extinguish the visual indicator. This switch must be overridden upon activation of a subsequent supervisory or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated if the supervisory or trouble condition still exists.

2.3.3 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Initiating devices must be manually reset by switch from the FACU after the initiating device or devices have been restored to normal.

2.3.4 Memory

Provide each control unit with non-volatile memory and logic for all

functions. The use of long life batteries, capacitors, or other age-dependent devices must not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.3.5 Field Programmability

Provide control units and control units that are fully field programmable for both input and output of control, initiation, notification, supervisory, and trouble functions. The system program configuration must be menu driven. System changes must be password protected. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system must be provided as part of this contract.

2.3.6 Input/Output Modifications

The FACU must contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features must consist of a control unit mounted keypad and a keyboard. Any bypass or modification to the system must indicate a trouble condition on the FACU.

2.3.7 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.3.8 Walk Test

The FACU must have a walk test feature. When using this feature, operation of initiating devices must result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated in the history log, but no other outputs occur.

2.3.9 History Logging

The control unit must have the ability to store a minimum of 400 events in a log. These events must be stored in a battery-protected memory and must remain in the memory until the memory is downloaded or cleared manually. Resetting of the control unit must not clear the memory.

2.3.10 Manual Access

An operator at the control unit, having a proper access level, must have the capability to manually access the following information for each initiating device.

a. Primary status.

b. Device type.

c. Present average value.

d. Present sensitivity selected.

e. Detector range (normal, dirty).

2.4 REMOTE ANNUNCIATOR

2.4.1 LCD Annunciator

Provide a semi-recessed or flush mounted annunciator that includes an LCD display. The display must indicate the device in trouble/alarm or any supervisory device. Display the device name, address, and actual building location. The remote annunciator shall duplicate functions of the FMCU for message display, fire alarm, supervisory alarm, and trouble conditions, visual and audible notification, and system reset functions. Remote annunciator shall require the use of a key for accessing the reset, control and other functions.

A building floor plan must be provided and mounted (behind Plexiglass or similar protective material) at the annunciator location. The floor plan must indicate all rooms by name and number including the locations of stairs and elevators. The floor plan must show all devices and their programmed address to facilitate identification of their physical location from the LCD display information.

2.5 MANUAL STATIONS

Provide metal or plastic, semi-flush mounted, double-action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations shall be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations shall be finished in fire-engine red with molded raised lettering operating instructions of contrasting color. The use of a key or wrench shall be required to reset the station. Stations shall have a separate screw terminal for each conductor.

Break rod-style manual stations shall not be used.

Manual stations shall be mounted at 42 inches.

Stations indicated to be weatherproof shall also be provided with clear tamper covers for supplemental protection. Equipment, devices, and supporting infrastructure shall be rated for the conditions identified on the environmental condition plans.

2.6 SMOKE DETECTORS

In accordance with UFC 3-600-01, provide all smoke detectors connected to the FACP with an adjustable alarm verification feature. Initially set the alarm verification at 20 seconds.

2.6.1 Spot Type Detectors

Provide addressable photoelectric smoke detectors as follows:

a. Provide analog/addressable photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke detectors must be listed for use with the FACU.

b. Provide self-restoring type detectors that do not require any readjustment after actuation at the FACU to restore them to normal operation. The detector must have a visual indicator to show

actuation.

c. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases with screw terminals for each conductor. The detectors must maintain contact with their bases without the use of springs.

e. The detector address must identify the particular unit, its location within the system. Detectors must be of the low voltage type rated for use on a 24 VDC system.

f. Where indicated on plans, sensors shall be rated for "harsh environment".

2.6.2 Duct Smoke Detectors

Duct-mounted addressable photoelectric smoke detectors must consist of a smoke detector, as specified in paragraph Spot Type Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry must be mounted in a metallic or plastic enclosure exterior to the duct. Detectors must be listed for operation over the complete range of air velocities, temperature and humidity expected at the detector when the air-handling system is operating. Detectors must be powered from the FACU. Provide remote test stations for each duct detector. Relays shall be installed to shut down all air handling for the events identified in the functional matrices. Coordinate with building DDC and mechanical/HVAC drawings and specifications. Rate for the environmental condition indicated on the drawings.

a. Sampling tubes must run the full width of the duct. The duct detector package must conform to the requirements of NFPA 90A, UL 268A, and must be listed for use in air-handling systems. The control functions, operation, reset, and bypass must be controlled from the FACU.

b. Lights to indicate the operation and alarm condition must be visible and accessible with the unit installed and the cover in place. Remote indicators must be provided where required by NFPA 72. Remote indicators as well as the affected fan units must be properly identified in etched plastic placards.

c. Detectors must provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 00 to INSTRUMENTATION AND CONTROL FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, and the FA- and M-series drawings. Auxiliary contacts provide for this function must be located within 3 feet of the controlled circuit or appliance. The auxiliary contacts must be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

2.6.3 Smoke Sensor Testing

Smoke sensors shall be tested in accordance with NFPA 72 and manufacturer's recommended calibrated test method. Submit smoke sensor

testing procedures for approval. In addition to the NFPA 72 requirements, smoke detector sensitivity shall be tested during the preliminary tests.

2.7 HEAT DETECTORS

See Section 21 13 18 for heat detector requirements.

2.8 Hydrogen Detectors

Provide an FM or UL listed/approved hydrogen monitors at location in which non-sealed batteries are provided. Provide alarm notification to the FACP and building DDC. Reference functional matrices for FACP functions upon hydrogen detection.

The hydrogen detection system shall be designed to activate when the level of flammable gas exceeds 25 percent of the lower flammability limit (LFL) for the gas or mixtures present at anticipated temperature and pressure per NFPA 69, consistent with 1 percent of the total volume per IFC and IMC. The LFL for hydrogen is 4 percent by volume of air per Bureau of Mines Bulletin 627. (Basis of design: MSA Safety Ultima X Series Monitors)

Detectors shall be provided with audible alarm.

Preference is for hydrogen detectors to be powered from the FACP (24VDC). Should the hydrogen detection system require 120VAC power, a circuit shall be provided from spare circuit breaker on a "Dedicated Emergency Branch" panel, and the detection system shall be provided with battery backup.

2.9 Carbon Monoxide Detectors

A carbon monoxide detector shall be installed in accordance with NFPA 720 (except as modified by UFC 3-600-01) above each gas-fueled equipment located on the building interior. Coordinate with final equipment locations and quantities. When associated with gas-fueled equipment, locate detectors within the manufacturer-recommended distance from the fuel-burning source. Additional detectors may be required beyond the quantity shown on the plans due to manufacturer proximity limitations. Per UFC 3-600-01, detectors shall be powered at 24VDC by the FACP.

Detectors shall be rated as required on the environmental conditions plans.

Detectors located in outside of hazardous areas shall be provided with Red LED for visual and 85 db at 10 feet for audible alarm. Malfunction indicator light shall be yellow or amber LED.

FACP signals shall activate at 50 ppm, the maximum allowable concentration for continuous exposure for healthy adults in any eight-hour period according to the Occupational Safety & Health Administration (OSHA).

Activation of a carbon monoxide detection device shall initiate a unique voice notification message.

2.10 MULTI SENSOR DETECTORS

Multi-sensor detectors shall not be used.

2.11 MULTI CRITERIA DETECTORS

Multi-criteria detectors shall not be used.

2.12 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored must be configured as a Class "A" initiating device circuits. The module must be listed as compatible with the control unit. The module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. Monitor module must contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED. Modules must be listed for the environmental conditions in which they will be installed.

Due to high ambient temperatures, addressable interface devices for equipment and devices located in the generator bay shall not be located in the generator bay. The location selected must be maintained between 60ºF-80ºF (15ºC-27ºC) and does not exceed 85% relative humidity at 80ºF.

2.13 ADDRESSABLE CONTROL MODULES

The control module must be capable of operating as a relay (dry contact form C) for interfacing the control unit with other systems, and to control door holders or initiate elevator fire service. The module must be listed as compatible with the control unit. The indicating device or the external load being controlled must be configured as Class A notification appliance circuits. The system must be capable of supervising, audible, visual and dry contact circuits. The control module must have both an input and output address. The supervision must detect a short on the supervised circuit and must prevent power from being applied to the circuit. The control model must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module must contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules must be listed for the environmental conditions in which they will be installed.

Due to high ambient temperatures, addressable control modules for equipment and devices located in the generator bay shall not be located in the generator bay. The location selected must be maintained between 60ºF-80ºF (15ºC-27ºC) and does not exceed 85% relative humidity at 80ºF.

2.14 ISOLATION MODULES

a. Provide isolation modules to subdivide each signaling line circuit into groups of not more than 20 addressable devicesin accordance with NFPA 72 between adjacent isolation modules.

b. Isolation modules must provide short circuit isolation for signaling line circuit wiring.

c. Power and communications must be supplied by the SLC and must report faults to the FACU.

d. After the wiring fault is repaired, the fault isolation modules must test the lines and automatically restore the connection.

Due to high ambient temperatures, isolation modules for equipment and devices located in the generator bay shall not be located in the generator bay. The location selected must be maintained between 60ºF-80ºF

(15°C-27°C) and does not exceed 85% relative humidity at 80°F.

2.15 NOTIFICATION APPLIANCES

Appliances and supporting infrastructure shall be rated in accordance with the environmental condition plans and suitable for the intended climatic and environmental conditions.

Combined fire alarm visual and audio devices shall be used where applicable and feasible.

See FA200 series sheets for coverage intent.

2.15.1 Audible Notification Appliances

Audible appliances must conform to the applicable requirements of UL 464. Appliances must be connected into notification appliance circuits. Surface mounted audible appliances must be painted red. Recessed audible appliances must be installed with a grill that is painted red. Audible Notification Appliances must be marked "ALERT" (per UFC 3-600-01 Subpart 9-18.6.3(l)) in letters of contrasting color.

a. Speakers shall conform to the applicable requirements of UL 1480. Speakers shall have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Interior speaker tap settings shall include taps of 1/8, 1/4, 1/2, 1, and 2 watts. Exterior speakers shall also be multi-tapped with no more than 15 watt maximum setting. Speakers shall incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 150 Hz to 10,000 Hz, and shall have a sealed back construction. Speakers shall be capable of installation on standard 4-inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single unit. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FMCP. Do not use speakers exceeding 15 watts for interior, non-cavernous applications.

b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 16 gauge or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted.

c. Speakers shall utilize screw terminals for termination of all field wiring.

Upon evacuation signal other than carbon monoxide, provide the following notification:

Three Pulse Temporal Pattern <Three Rounds> (1000 Hz tones as required in 18.4.2.1 of NFPA 72), followed by the below message.
"MAY I HAVE YOUR ATTENTION PLEASE. MAY I HAVE YOUR ATTENTION PLEASE. A FIRE EMERGENCY HAS BEEN REPORTED IN THE BUILDING. PLEASE LEAVE THE BUILDING BY THE NEAREST EXIT."
Provide a 2-second pause.
Repeat.

Upon carbon monoxide detection, provide the following notification:

Temporal 4 Alert Tone (520 Hz) in accordance with NFPA 720. Alert tone shall repeat twice before the voice announcement (UFC 3-600-01 Section 9-19.3.1.1).
"ATTENTION, PLEASE… ATTENTION, PLEASE… CARBON MONOXIDE HAS BEEN DETECTED IN THE BUILDING. PLEASE LEAVE THE BUILDING BY THE NEAREST EXIT."
Repeat.

2.15.1.1 Horns

Horns must be semi-flush mounted or surface-mounted, with the matching mounting backbox surface mounted vibrating type suitable for use in an electrically supervised circuit. Horns must produce a sound rating of at least 85 dBA at 10 feet. Horns used in exterior locations must be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

2.15.2 Visual Notification Appliances

Visual notification appliances must conform to the applicable requirements of UL 1638, UL 1971 and conform to the Architectural Barriers Act (ABA). Visual Notification Appliances must have clear high intensity optic lens, xenon flash tubes, or light emitting diode (LED) and be marked "ALERT" (per UFC 3-600-01 Subpart 9-18.6.3(l)) in letters of contrasting color. The light pattern must be disbursed so that it is visible above and below the strobe and from a 90 degree angle on both sides of the strobe. Strobe flash rate must be 1 flash per second and a minimum of 15 candela based on the UL 1971 test. Strobe must be surface mounted.

Contractor shall determine visual notification appliance intensity settings based on NFPA 72 analysis for a given space.

Where more than two notification appliances are located in the same room or field of view, provide synchronized operation.

Devices shall use screw terminals for all field wiring.

2.16 ELECTRIC POWER

2.16.1 Primary Power

Power must be 120 VAC service for the FACU and RSCP from the AC service to the building in accordance with NFPA 72 and UFC 3-520-01 via the "local emergency power panel(s)" in this facility shall be panels associated with the 'NLF' panel.

The contractor shall submit for government approval Dedicated Emergency Panel Schedules for adjustments to be made to the described panel(s). The schedule(s) for described panel(s) included on the EP600 series sheets was(were) assembled with assumed loads to account for sufficient capacity of equipment requiring connection to the UFC 3-520-01 dedicated "emergency" panels. The Dedicated Emergency Panel Schedules shall be provided with actual equipment, device, and system loads and number of poles for the proposed and approved components, and shall be balanced to the greatest degree possible while grouping circuits by spatial and routing proximity (i.e., circuits going to similar locations shall be grouped together; see the contract drawing panel schedules for the concept

relative to the contract drawing equipment and device layout). All open poles on the panel shall be provided with 20A spare breakers. This requirement requires a substantially-developed fire alarm/mass notification/releasing service/containment/etc. systems design; Coordinate across trades for timely delivery of this information.

The branch(es) from the main switchboard(s) through the described panels shall be considered the "Dedicated Emergency Branch(es)". All alternating-current power for fire protection systems shall be supplied from a panel designated for such use except as explicitly indicated otherwise (such as fire pumps).

2.17 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power must be automatic and must not cause transmission of a false alarm.

2.17.1 Batteries

Provide sealed, maintenance-free, sealed lead acid batteries as the source for emergency power to the FACU. Batteries must contain suspended electrolyte. The battery system must be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power.

The battery cabinet shall have adequate space for spare duplicate storage batteries. Batteries shall not be located outside of enclosures, whether with the equipment the batteries are supplying or remotely located. Include product data for battery cabinets when located remote from the equipment it serves. Batteries shall be mounted on a noncorrosive and nonconductive base or pad.

2.17.1.1 Capacity

Battery size must be the following capacity. This capacity applies to every control unit associated with this system, including supplemental notification appliance circuit panels, auxiliary power supply panels, and fire alarm transmitters.

a. Sufficient capacity to operate the fire alarm system and the releasing service system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes.

b. While the conditions of NFPA 72 §10.6.7.3.1(2) and NFPA 72 §10.6.11.3.1 may be present and supplying the fire alarm system in this facility, the Tri-Services (Army, Air Force (including Space Force), Navy (including Marine Corps) Fire Protection Discipline Working Group (DWG) has indicated via the criteria change request process the battery capacity indicated in the previous item is not to be curtailed regardless of the presence of supply to the fire alarm system by an NFPA 70 Article 700 Emergency System (CCR 16194).

2.17.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power

requirements for the criteria noted in the paragraph "Capacity" above.

(1) Substantiate the battery calculations for alarm and supervisory power requirements. Include ampere-hour requirements for each system component and each control unit component, and compliance with UL 864.

(2) Provide complete battery calculations for both the alarm and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.

(3) Provide voltage drop calculations to indicate that sufficient voltage is available for proper operation of the system and all components. Calculations must be performed using the minimum rated voltage of each component.

(4) Calculations including ampere-hour requirements for each system component and each panel component, and the battery recharging period, shall be included on the drawings.

b. For battery calculations assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period. Using 20.4 VDC as starting voltage, perform a voltage drop calculation for circuits containing device and/or appliances remote from the power sources.

See additional requirements for spare capacity in Subpart "SYSTEM OPERATION".

2.17.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger must be capable of providing 120 percent of the connected system load and must maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger must recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided. Provide calculations demonstrating recharge duration requirements are satisfied.

2.18 SURGE PROTECTIVE DEVICES

Surge protective devices must be provided to suppress all voltage transients which might damage fire alarm control unit components. Systems having circuits located outdoors, communications equipment must be protected against surges induced on any signaling line circuit. Cables and conductors, that serve as communications links, must have surge protection circuits installed at each end. The surge protective device must wire in series to the power supply of the protected equipment with screw terminations. Line voltage surge arrestor must be installed directly adjacent to the power panel where the FACU and RSCP breakers are located.

a. Surge protective devices for nominal 120 VAC must be UL 1449 listed

with a maximum 500 volt suppression level and have a maximum response time of 5 nanoseconds. The surge protective device must also meet IEEE C62.41.1 and IEEE C62.41.2 category B tests for surge capacity. The surge protective device must feature multi-stage construction and be provided with a long-life indicator lamp (either light emitting diode or neon) which extinguishes upon failure of protected components. Any unit fusing must be externally accessible.

b. Surge protective devices for nominal 24 VAC, fire alarm telephone dialer, or ethernet connection must be UL 497B listed, meet IEEE C62.41.1 and have a maximum response time of 1-nanosecond. The surge protective device must feature multi-stage construction and be self-resetting. The surge protective device must be a base and plug style. The base assembly must have screw terminals for fire alarm wiring. The base assembly must accept "plug-in" surge protective module.

c. All surge protective devices (SPD) must be the standard product of a single manufacturer and be equal or better than the following:

(1) For 120 VAC nominal line voltage: UL 1449 and UL 1283 listed, series connected 120 VAC, 20A rated, surge protective device in a NEMA 4x enclosure. Minimum 50,000 amp surge current rating with EMI/RFI filtering and a dry contact circuit for remote monitoring of surge protection status.

(2) For 24-volt nominal line voltage: UL 497B listed, series connected low voltage, 24-volt, 5A rated, loop circuit protector, base and replaceable module.

(3) For alarm telephone dialers: UL 497A listed, series connected, 130-volt, 150 mA rated with self-resetting fuse, dialer circuit protector with modular plug and play.

(4) For IP-DACTS: UL 497B listed, series connected, 6.4-volt, 1.5A rated with 20 kA/pair surge current, data network protector with modular plug and play.

All control panels must have TVSS on all fire alarm circuits entering and leaving the facility, including, but not limited to, the power supply circuits to the control panels, circuits interfacing with fire pumping equipment the facility, and circuits interfacing with the fire alarm receiving station (e.g., communication circuits, antenna systems). Provide SPDs to protect all power supply circuits to the FACP, RSCP, CAES, and CSMP, including any subpanels such as autonomous control units, amplifier panels, BVR, CSMP, and Notification Appliance Circuit (NAC) booster panels. Provide SPDs in accordance with UFC 3-520-01. Mount SPDs in a separate enclosure, unless the SPD is listed and installed in the control panel by the factory. Installing SPDs not listed with the panel is prohibited.

Alternating Current (ac) Power TVSS Devices. These devices will have been tested in accordance with UL 1449, Standard for Safety Transient Voltage Surge Suppressors, Second Edition, and UL 1283, Electromagnetic Interference Filters, latest edition, by a nationally recognized testing laboratory. The TVSS devices must provide normal sine wave tracking, with Category A1 ring wave suppression (2000 volts, 67 amperes, 180 degrees) of less than 50 V for nominal 120 V alternating current (Vac) legs. The TVSS will provide independent, distinct, and dedicated circuitry for each

possible protection mode (i.e., line-to-line, line-to-neutral, line-to-ground, neutral-to-ground). TVSS device circuitry must be fully encapsulated for protection of the circuitry and to provide longer life expectancy.

Data, Signal, and Control Wire TVSS Devices. The TVSS devices must be designed by the same manufacturer as the ac power TVSS devices to ensure overall compatibility and system reliability. The TVSS manufacturer will provide the TVSS devices based on evaluation of individual system parameters, including: conductor size and length, number of conductors, shield type, peak current and voltage, signal type, signal baud rate, frequency bandwidth, maximum attenuation, maximum standing-wave ratio, and maximum reflection coefficient. TVSS device circuitry must be fully encapsulated for protection of the circuitry and to provide longer life expectancy.

Circuits traveling away from the building (such as to the PIV tamper switch) shall be provided with TVSS.

2.18.1 Signaling Line Circuit Surge Protection

For systems having circuits located outdoors, communications equipment shall be protected against surges induced on any signaling line circuit and shall comply with the applicable requirements of IEEE C62.41.1 and IEEE C62.41.2. Cables and conductors, that serve as communications links, shall have surge protection circuits installed at each end that meet the following waveform(s):

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Protection shall be provided at the equipment. Additional triple electrode gas surge protectors, rated for the application, shall be installed on each wireline circuit within 3 feet of the building cable entrance. Fuses shall not be used for surge protection.

2.18.2 Sensor Wiring Surge Protection

Digital and analog inputs and outputs shall be protected against surges induced by sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested with the following waveforms:

a. A 10 by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Fuses shall not be used for surge protection.

2.19 WIRING

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein. Wiring methods shall comply with NFPA 70 and NFPA 72. Wiring for alternating current (AC) circuits shall be 12 AWG minimum. All wiring and cables shall be routed in enclosed raceway.

Power wiring and power-limited wiring shall not be co-located in the same conduit, raceway, or enclosure. Such wiring may only be co-located within the listed control panel and shall be installed in accordance with the manufacturer's guidance.

For all fire alarm circuiting in the generator bay, provide watertight conduit/connections and minimum NEMA 4 junction boxes, back boxes, and enclosures. Where the conduit is in a hazardously classified area, additionally provide breathers in isolated portions of the conduit (e.g. sealed off from the remaining conduit system). Drains and breathers shall be rated for the hazardous classification in which they are installed, but shall not be less than NEMA 4.

Reference environmental conditions plans.

2.19.1 Alarm Wiring

IDC and SLC wiring must be fiber optic or solid copper cable in accordance with the manufacturers requirements. Copper signaling line circuits and initiating device circuit field wiring must be No. 16 AWG size conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, must be copper No. 14 AWG size conductors at a minimum. Wire size must be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC must not operate at less than the listed voltages for the detectors and/or appliances. Power wiring, operating at 120 VAC minimum, must be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables must comply with NFPA 70.

2.20 AUTOMATIC FIRE ALARM TRANSMITTERS

2.20.1 Radio Transmitter and Interface Panels

Transmitters must be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter must be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters must be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module must be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is AES Corporation and the transmitter must be fully compatible with this equipment. At the contractors option, and if listed, the transmitter may be housed in the same control unit as the FAC. The transmitter must be narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency Management.

The Buckley SFB Fire Reporting System consists of and this contract shall use as a sole source AES Radio Frequency Transceiver (AES Corporation Transceiver IntelliNet 2.0 Part # 7707P-88-ULP-M) which reports through an AES Net Mesh proprietary system over an FCC-approved Buckley SFB frequency of 413.2MHZ to the 911 center in Building 1028.

Use of radio frequency-type communications systems shall comply with National Telecommunications and Information Administration (NTIA)

requirements.

2.20.1.1 Operation

Operate each transmitter from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter must automatically switch to battery operation. Switchover must be accomplished with no interruption of protective service, and must automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply must also be automatic.

2.20.1.2 Battery Power

Transmitter standby battery capacity must provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.

2.20.1.3 Transmitter Housing

Use NEMA Type 1 for housing. The housing must contain a lock that is keyed identical to the fire alarm system for the building. Radio alarm transmitter housing must be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.

2.20.1.4 Antenna

Antenna must be omnidirectional, coaxial, halfwave dipole antennas for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts must be corrosion resistant and designed to withstand wind velocities of 100 mph. Do not mount antennas to any portion of the building roofing system. Protect the antenna from physical damage.

Locate antenna where indicated on FA sheets. Ground the antenna bracket using minimum 4 AWG copper wire to a suitable earth ground.

2.20.2 Signals to Be Transmitted to the Base Receiving Station

The following signals must be sent to the base receiving station:

a. Sprinkler waterflow

b. Manual pull stations

c. Smoke detectors

d. Duct smoke detectors

e. Carbon monoxide detectors

g. Heat detectors

i. Sprinkler valve supervision

j. Fire pump running

k. Fire pump supervision

m. Combustion engine drive fire pump running

(1) Selector switch in position than automatic

(2) Engine over-speed

(3) Low fuel

(4) Low battery

(5) Engine trouble (for example, low oil, over temp)

n. Additional signals as identified on FA600 matrices

2.21 SYSTEM MONITORING

The fire alarm and releasing service systems shall be completely supervised systems employing addressable initiating devices and multiplex communication techniques. Each detection, monitoring, and control device shall be individually addressable. Devices which are not inherently addressable (i.e. tamper switches, flow switches, door holders, etc.) shall be equipped with addressable monitor and/or control modules as applicable.

Monitoring of devices shall be as indicated on FA600 series riser and functional matrices by the FACP or the RSCP.

2.21.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, standpipe control valves, sprinkler service entrance valve, valves at fire pumps, isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, must be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address.

2.21.1.1 Tamper Switches

Provide tamper switches where indicated on the plans and as required by this section and Division 21 Sections.

2.21.2 High/Low Nitrogen Supervisory Switches

Provide monitoring of high and low supervisory nitrogen for preaction systems. Each air supervisory switch must have a separate address. Switches must be listed extinguishing system attachments. The device must contain double pole, double throw contacts. Operation of the switch must cause a supervisory signal to be transmitted to the FACU when nitrogen pressure in the system monitored sprinkler system increases more than the value indicated in 21 13 18 above the normal system pressure or drops halfway from the normal pressure to the tripping point.

2.21.3 Room Low Temperature Supervisory Switch

Provide low temperature sensors for monitoring of the listed supervisory air temperature switch for the fire pump rooms. Switch must cause a supervisory signal to be transmitted to the FACU whenever the temperature in the room drops to below 40 degrees F. Device must reset when temperature rises above 40 degrees F.

Alarm low temperature conditions at the FACP as a supervisory condition and the Energy Management Control System. Coordinate with building DDC and the functional matrices.

2.21.4 Diesel Fire Pump Tank Level Sensor

Provide any devices, conduits, or electrical enclosures within the storage tank, including the Containment System Level Sensor, for an electrical (hazard) classification of Class I Division 1 and for prolonged submersion. Report low fuel level as required by the diesel fire pump monitoring system.

Diesel Fire Pump Tank Leak Detection Monitoring

Provide leak detection monitoring to perform continuous integrity checks on the status of each sensor's connections and wiring and interface with the diesel fire pump monitoring system. Leak detection alarms shall be latching type. Alarm may be silenced but shall not be cleared until the panel is reset.

2.21.5 Pressure Switches

Pressure switch shall include a metal housing with a neoprene diaphragm, SPDT snap action switches. The switch shall have a service pressure rating of 175 psi. There shall be two SPDT (Form C) contacts factory adjusted to operate at 4 to 8 psi. The switch shall be capable of being mounted in any position in the alarm line trim piping of the alarm check valve.

Provide pressure switches where indicated on the plans and as required by this section and Division 21 Sections.

2.21.6 Waterflow Detectors

Provide waterflow detectors where indicated on the plans and as required by this section and Division 21 Sections (Sprinkler Alarm Switches).

2.21.7 Solenoid Disconnect Switches

Provide a key-operated supervised disconnect switch to physically disable the solenoid/control valve for each foam/water and preaction riser. Provide switch which disables the releasing functions without the use of programming, while leaving all other functions of the panel operational. Do not provide a trouble signal upon operation of the disconnect. Monitor the preaction water disconnect switches at the RSCP. Provide a supervisory signal to the receiving station upon operation of the disconnect.

Locate the disconnect switch in Fire Pump Room in a readily accessible location near the solenoid/control valve. Provide a sign near the disconnect switch with a white background and a minimum 1/2 inch wide blue border, with "DISABLE PREACTION SYSTEM" accordingly in red lettering not less than 1 inch (25.4 mm) high. Provide engraved labels on the disconnect switch indicating when the system is "ENABLED" or "DISABLED". Do not install backboxes or route conduit in front of sign in a manner that obstructs any lettering.

2.22 ENVIRONMENTAL ENCLOSURES OR GUARDS

Environmental enclosures must be provided to permit fire alarm components to be used in areas that exceed the environmental limits of the listing. The enclosure must be listed for the device or appliance as either a manufactured part number or as a listed compatible accessory for the component is currently listed. Guards required to deter mechanical damage must be either a listed manufactured part or a listed accessory for the category of the initiating device or notification appliance.

Reference environmental condition and areas subject to physical damage plans.

PART 3 EXECUTION

3.1 VERIFYING ACTUAL FIELD CONDITIONS

Before commencing work, examine all adjoining work on which the contractor's work is in any way dependent for perfect workmanship according to the intent of this specification section, and report to the Contracting Officer's Representative any condition which prevents performance of first class work. No "waiver of responsibility" for incomplete, inadequate or defective adjoining work will be considered unless notice has been filed before submittal of a proposal.

3.2 INSTALLATION

3.2.1 Fire Alarm Control Unit (FACU)

Locate the FACU where indicated on the drawings. Mount the enclosure with the top of the cabinet 6 feet above the finished floor or center the cabinet at 5 feet, whichever is lower. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the FACU. Locate the document storage cabinet adjacent to the FACU unless the Contracting Officer directs otherwise.

3.2.2 Battery Cabinets

When batteries will not fit in the FACU, locate battery cabinets below or adjacent to the FACU. Battery cabinets must be installed at an accessible location when standing at floor level. Battery cabinets must not be installed lower than 12 inches above finished floor, measured to the bottom of the cabinet, nor higher than 36 inches above the floor, measured to the top of the cabinet. Installing batteries above drop ceilings or in inaccessible locations is prohibited. Battery cabinets must be large enough to accommodate batteries and also to allow ample gutter space for interconnection of control units as well as field wiring. The cabinet must be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.The cabinet must be identified by an engraved phenolic resin nameplate. Lettering on the nameplate must indicate the control unit(s) the batteries power and must not be less than 1-inch high.

3.2.3 Manual Stations

Locate manual stations as required by NFPA 72 and as indicated on the drawings. Mount stations so they are located no farther than 5 feet from the exit door they serve, measured horizontally. Manual stations must be

mounted at 42 inches measured to the operating handle.

3.2.4 Notification Appliances

a. Locate notification appliance devices as required by NFPA 72. Where more than two visual notification appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices must use screw terminals for all field wiring. Audible and visual notification appliances mounted in acoustical ceiling tiles must be centered in the tiles plus or minus 2 inches..

b. Audible and visual notification appliances mounted on the exterior of the building, within unconditioned spaces, or in the vicinity of showers must be listed weatherproof appliances installed on weatherproof backboxes.

c. Speakers must not be located in close proximity to the FACU or LOC so as to cause feedback when the microphone is in use.

3.2.5 Smoke and Heat Detectors

Locate detectors as required by NFPA 72, UFC 3-600-01, and their listing on a 4-inch mounting box. Install heat detectors not less than 4 inches from a side wall to the near edge. Heat detectors located on the wall must have the top of the detector at least 4 inches below the ceiling, but not more than 12 inches below the ceiling. Smoke detectors are permitted to be on the wall no lower than 12 inches from the ceiling with no minimum distance from the ceiling. Install smoke detectors no closer than 3 feet from air handling supply diffusers. Detectors installed in acoustical ceiling tiles must be centered in the tiles plus or minus 2 inches.

3.2.6 LCD REMOTE Annunciator

Locate the LCD annunciator as shown on the drawings. Mount the annunciator, with the top 6 feet above the finished floor or center the annunciator at 5 feet, whichever is lower.

3.2.7 Ceiling Bridges

Provide ceiling bridges for ceiling-mounted appliances. Ceiling bridges must be as recommended/required by the manufacturer of the ceiling-mounted notification appliance.

3.3 SYSTEM FIELD WIRING

3.3.1 Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box must be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Wiring to conform with NFPA 70.

Indicate the following in the wiring diagrams:

a. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system,

including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams must show connections from field devices to the RSCP, FACU, and remote fire alarm control units, initiating circuits, switches, relays and terminals.

b. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

3.3.2 Terminal Cabinets

Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size must be appropriate for the size of the wiring to be connected. Conductor terminations must be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection must be permanently mounted in the terminal cabinet. Minimum size is 8 inches by 8 inches. Only screw-type terminals are permitted. Provide an identification label, that displays "FIRE ALARM TERMINAL CABINET" with 2-inch lettering, on the front of the terminal cabinet.

3.3.3 Alarm Wiring

a. Voltages must not be mixed in any junction box, housing or device, except those containing power supplies and control relays.

b. Utilize shielded wiring where recommended by the manufacturer. For shielded wiring, ground the shield at only one point, in or adjacent to the FACU.

c. Pigtail or T-tap connections to signal line circuits, initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. T-tapping using screw terminal blocks is allowed for Class "B" signaling line circuits only and not applicable to this project.

d. Color coding is required for circuits and must be maintained throughout the circuit. Conductors used for the same functions must be similarly color coded. Conform wiring to NFPA 70.

e. Pull all conductors splice free. The use of wire nuts, crimped connectors, or twisting of conductors is prohibited. Where splices are unavoidable, the location of the junction box or pull box where they occur must be identified on the as-built drawings. The number and location of splices must be subject to approval by the Designated Fire Protection Engineer (DFPE).

3.3.4 Back Boxes and Conduit

In addition to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, provide all wiring in rigid metal conduit or intermediate metal conduit unless specifically indicated otherwise. Minimum conduit size must be 3/4-inch in diameter. Do not use electrical non-metallic tubing (ENT) or flexible non-metallic tubing and associated fittings.

a. Galvanized rigid steel (GRS) conduit must be utilized where exposed to weather, where subject to physical damage, and where exposed on

exterior of buildings. Intermediate metal conduit (IMC) may be used in lieu of GRS as allowed by NFPA 70.

b. Electrical metallic tubing (EMT) is permitted above suspended ceilings or exposed where not subject to physical damage. Do not use EMT underground, encased in concrete, mortar, or grout, in hazardous locations, where exposed to physical damage, outdoors or in fire pump rooms. Use die-cast compression connectors.

c. For rigid metallic conduit (RMC), only threaded type fitting are permitted for wet or damp locations.

d. Flexible metal conduit is permitted for initiating device circuits 6 feet in length or less. Flexible metal conduit is prohibited for notification appliance circuits and signaling line circuits. Use liquid tight flexible metal conduit in damp and wet locations.

e. Schedule 40 (minimum) polyvinyl chloride (PVC) is permitted where conduit is routed underground or underground below floor slabs. Convert non-metallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before turning up through floor slab.

f. Exterior wall penetrations must be weathertight. Conduit must be sealed to prevent the infiltration of moisture.

g. For Class "A" or "X" circuits with conductor lengths of 10 feet or less, the conductors must be permitted to be installed in the same raceway in accordance with NFPA 72.

3.3.5 Conductor Terminations

Labeling of conductors at terminal blocks in terminal cabinets, FACU, RSCP, and remote FACU must be provided at each conductor connection. Each conductor or cable must have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FACU, and remote FACU must contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing must be neat, using 12 point lettering minimum size, and mounted within each cabinet, control unit, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.4 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire-rated walls, partitions with fire-rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.5 PAINTING

a. In unfinished areas (including areas above drop ceilings), paint all exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceway, junction boxes and covers red. In lieu of painting conduit, the contractor may utilize red conduit with a factory applied finish.

b. In finished areas, paint exposed electrical conduit (serving fire alarm equipment), fire alarm conduit, surface metal raceways, junction

boxes, and electrical boxes to match adjacent finishes. The inside cover of the junction box must be identified as "Fire Alarm" and the conduit must have painted red bands 3/4-inch wide at 10-foot centers and at each side of a floor, wall, or ceiling penetration.

c. Painting must comply with Section 09 90 00 PAINTS AND COATINGS.

3.6 FIELD QUALITY CONTROL

3.6.1 Test Procedures

Submit detailed test procedures, prepared and signed by the NICET Level IV Fire Alarm Technician, and the representative of the installing company, 60 days prior to performing system tests. Detailed test procedures must list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment, interface equipment, and surge protective devices. Test procedures must include sequence of testing, time estimate for each test, and sample test data forms. The test data forms must be in a check-off format (pass/fail with space to add applicable test data; similar to the forma in NFPA 72 and NFPA 4.) The test procedures and accompanying test data forms must be used for the pre-Government testing and the Government testing. The test data forms must record the test results and must:

a. Identify the NFPA Class of all Initiating Device Circuits (IDC), and Notification Appliance Circuits (NAC), and Signaling Line Circuits (SLC).

b. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component, and describe how these tests must be performed.

c. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each component location, test location, and alphanumeric identity.

d. Identify all test equipment and personnel required to perform each test (including equipment necessary for smoke detector testing. The use of magnets is not permitted.

e. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test.

3.6.2 Pre-Government Testing

3.6.2.1 Verification of Compliant Installation

Conduct inspections and tests to ensure that devices and circuits are functioning properly. Tests must meet the requirements of paragraph entitled "Minimum System Tests" as required by NFPA 72. The contractor and an authorized representative from each supplier of equipment must be in attendance at the pre-Government testing to make necessary adjustments. After inspection and testing is complete, provide a signed Verification of Compliant Installation letter by the QFPE that the

installation is complete, compliant with the specification and fully operable. The letter must include the names and titles of the witnesses to the pre-Government tests. Provide all completion documentation as required by NFPA 72 including all referenced annex sections and the test reports noted below.

a. NFPA 72 Record of Completion.

b. NFPA 72 Record of Inspection and Testing.

c. Fire Alarm and Emergency Communication System Inspection and Testing Form.

d. Audibility test results with marked-up test floor plans.

e. Documentation that all tests identified in the paragraph "Minimum System Tests" are complete.

3.6.2.2 Request for Government Final Test

When the verification of compliant installation has been completed, submit a formal request for Government final test to the Contracting Officer's Representative (COR). Government final testing will not be scheduled until the DFPE has received copies of the request for Government final testing and Verification of Compliant Installation letter with all required reports. Government final testing will not be performed until after the connections to the installation-wide fire reporting system has been completed and tested to confirm communications are fully functional. Submit request for test at least 30 calendar days prior to the requested test date.

3.6.3 Correction of Deficiencies

If equipment was found to be defective or non-compliant with contract requirements, perform corrective actions and repeat the tests. Tests must be conducted and repeated if necessary until the system has been demonstrated to comply with all contract requirements.

3.6.4 Government Final Tests

The tests must be performed in accordance with the approved test procedures in the presence of the DFPE. Furnish instruments and personnel required for the tests. The following must be provided at the job site for Government Final Testing:

a. The manufacturer's technical representative.

b. The contractor's Qualified Fire Protection Engineer (QFPE).

c. Marked-up red line drawings of the system as actually installed.

d. Loop resistance test results.

e. Complete program printout including input/output addresses.

f. Copy of pre-Government Test Certificate, test procedures and completed test data forms.

g. Audibility test results with marked-up floor plans.

Government Final Tests will be witnessed by the Contracting Officer's Representative (COR). At this time, any and all required tests noted in the paragraph "Minimum System Tests" must be repeated at their discretion.

3.7 MINIMUM SYSTEM TESTS

3.7.1 System Tests

Test the system in accordance with the procedures outlined in NFPA 72. The required tests are as follows:

a. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests must be witnessed by the Contracting Officer and test results recorded for use at the final Government test.

b. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be accomplished at the pre-Government test with results available at the final system test.

c. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

d. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.

f. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

g. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

h. Determine that the system is operable under trouble conditions as specified.

i. Visually inspect wiring.

j. Test the battery charger and batteries.

k. Verify that software control and data files have been entered or programmed into the FACU. Hard copy records of the software must be provided to the Contracting Officer.

l. Verify red-line drawings are accurate.

m. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

n. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

o. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must be conducted using real smoke or the use of canned smoke which is permitted.

p. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.

q. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

3.7.2 Audibility Tests

Sound pressure levels from audible notification appliances must be a minimum of 15 dBa over ambient with a maximum of 110 dBa in any occupiable area. The provisions for audible notification (audibility and intelligibility) must be met with doors, fire shutters, movable partitions, and similar devices closed.

3.8 SYSTEM ACCEPTANCE

Following acceptance of the system, as-built drawings and O&M manuals must be delivered to the Contracting Officer for review and acceptance. The drawings must show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings must be submitted within two weeks after the final Government test of the system. At least one set of as-built (marked-up) drawings must be provided at the time of, or prior to the Final Government Test.

a. The drawings must be prepared electronically and sized no less than the contract drawings. Furnish one set of CDs or DVDs containing software back-up and CAD based drawings in latest version of AutoCAD, DXF and portable document formats of as-built drawings and schematics.

b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired.

c. Include a riser diagram and drawings showing the as-built location of devices and equipment.

d. Provide Operation and Maintenance (O&M) Instructions. See "Operation and Maintenance(O&M) Instructions" in Part 1.

3.9 INSTRUCTION OF GOVERNMENT EMPLOYEES

3.9.1 Instructor

Provide the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the operation, inspection, testing, and maintenance of the system provided. The instructor must train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm and releasing service systems. The instructor must be thoroughly familiar with all parts of this installation. The instructor must be trained in operating theory as well as in practical O&M work. Submit the instructors information and qualifications including the

training history.

3.9.2 Required Instruction Time

Provide minimum 8 hours of instruction after final acceptance of the system. The instruction must be given during regular working hours on such dates and times selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training must allow for rescheduling for unforeseen maintenance and/or fire department responses.

The training course shall be conducted for minimum six (6) operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. The training course shall be conducted at the project site and the Government reserves the right to make audio and visual recordings of the training sessions for later use. Audiovisual equipment and four (4) sets of all other training materials and supplies shall be provided.

3.9.2.1 Technical Training

Equipment manufacturer or a factory representative must provide 1 day of on site. Training must allow for classroom instruction as well as individual hands on programming, troubleshooting and diagnostics exercises. Factory training must occur within 6 months of system acceptance.

3.9.3 Training Documentation

Prepare training documentation consisting of the following:

a. Course Attendee List: A list of course attendees which shall be developed in coordination with and signed by the fire department and maintenance shop supervisors.

b. Training Manuals: Training manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson, as well as operating instructions, maintenance procedures, and training data for the system(s). The operations training shall familiarize designated government personnel with proper operation of the installed system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

c. Where the Contractor presents portions of the course material by audiovisuals, copies of those audiovisuals shall be delivered to the Government as a part of the printed training manuals. Training manuals shall be delivered for each trainee with two (2) additional copies delivered for archival at the project site. Training manuals shall be delivered for each trainee on the Course Attendee List with two (2) additional copies delivered for archival at the project site. Two (2) copies of the Course Attendee List shall be delivered with the archival copies. The Training Documentation may be submitted as a Technical Data Package.

3.9.4 Training Course Content

The training course shall cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each

control enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, repair procedures, and use of the software, along with demonstration of modifiable system and operation settings. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system.

3.10 Technical Data and Computer Software

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training shall familiarize designated government personnel with proper operation of the installed system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

3.11 PASSWORDS

All programming codes and passwords shall be provided to base fire department no later than the date of final system acceptance.

3.12 EXTRA MATERIALS

3.12.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system must be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During the warranty period, the service technician must be on-site within 24 hours after notification. All repairs must be completed within 24 hours of arrival on-site.

During the warranty period, the installing fire alarm contractor is responsible for conducting all required testing and maintenance in accordance with the requirements and recommended practices of NFPA 72 and the system manufacturer. Installing fire alarm contractor is NOT responsible for any damage resulting from abuse, misuse, or neglect of equipment by the end user.

3.12.2 Spare Parts

Spare parts furnished must be directly interchangeable with the corresponding components of the installed system. Spare parts must be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts must be delivered to the Contracting Officer at the time of the Government testing and must be accompanied by an inventory list.

3.12.3 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer.

3.12.4 Document Storage Cabinet

Upon completion of the project, but prior to project close-out, place in the document storage cabinet copies of the following record documentation:

a. As-built shop drawings

b. Product data sheets

c. Design calculations

d. Site-specific software data package

e. All documentation required by SD-06.

Locate the document storage cabinet in the Electrical Room (104) unless the Contracting Officer directs otherwise.

-- End of Section --

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SECTION 31 00 00

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08/23

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SECTION 31 00 00

EARTHWORK
08/23

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600	(2017) Installation of Ductile-Iron Mains and Their Appurtenances

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2023) Standard Specification for Concrete Aggregates
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2022) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1140	(2017) Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for

	Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2015) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	(2016; E 2019) Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	(2016) Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4832	(2016; E 2018) Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D5268	(2019) Topsoil Used for Landscaping Purposes
ASTM D6023	(2016) Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM)
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes

EPA SW-846.3-3	(1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

1.2 DEFINITIONS

1.2.1 Structural Fill

Soil material placed to support buildings, walls, pads, and other similar facilities.

1.2.2 Embankment Fill

Soil material placed to construct embankment.

1.2.3 Porous Fill

Free-draining material placed for subsurface drainage, as a capillary break, or another specific purpose. See also Capillary Water Barrier.

1.2.4 Topsoil

Surface layer of primarily organic soil capable of supporting vegetation growth.

1.2.5 Utility Bedding Material

Fill placed to directly support pipes, conduits, cables, and appurtenant structures. Bedding may also be used to provide a cushion between utilities and bedrock, obstacles, obstructions and other unyielding materials.

1.2.6 Flowable Fill

Fill placed in a plastic or liquid form that flows to near its final placement location with limited assistance and subsequently cures or solidifies to provide a stable or impermeable barrier.

1.2.7 Satisfactory Materials

Satisfactory materials for fill, backfill, and/or any in-situ soils to remain in place comprise any materials classified by ASTM D2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC,SW-SC, SP-SM, SP-SC, CL, and CL-ML. Maximum particle size to be no greater than 3 inches in any dimension.

1.2.8 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; roots and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials.

1.2.9 Cohesionless Materials

Cohesionless materials include materials classified in ASTM D2487 as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing,

required for classifying materials, in accordance with ASTM D4318, ASTM C117, ASTM C136/C136M and ASTM D1140.

1.2.10 Cohesive Materials

Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesive only when the fines are plastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C117, ASTM C136/C136M and ASTM D1140.

1.2.11 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 12 inch in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.2.12 Unstable Material

Unstable materials are too weak to adequately support the utility pipe, conduit, equipment, or appurtenant structure. Satisfactory material may become unstable due to ineffective drainage, dewatering, becoming frozen, excessive loading.

1.2.13 Expansive Soils

Expansive soils are defined as soils that have a plasticity index greater than 20 when tested in accordance with ASTM D4318.

1.2.14 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.2.15 Capillary Water Barrier

A layer of clean, poorly graded crushed rock, stone, or natural sand or gravel having a high porosity which is placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below a slab. See also Porous Fill.

1.2.16 Degree of Compaction (Proctor)

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30

percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180-21 paragraph 1.5, Note 1.

1.2.17 Degree of Compaction (Relative Density)

Degree of compaction required for soils with less than 5 percent passing the No. 200 sieve, is expressed as a relative percentage of the maximum index density/dry unit weight and minimum index density/dry unit weight, obtained by the test procedures in accordance with ASTM D4253 and ASTM D4254, respectively, abbreviated as a percent of laboratory relative density.

1.2.18 Borrow

Soil brought to the project site from an external location for the purposes of project construction.

1.2.19 Subgrade

Earth materials directly below foundations and directly below granular base materials in building slab and pavement areas including shoulders.

1.3 SUBSURFACE DATA

Subsurface soil boring logs are shown in project plans. These data represent available subsurface information; however, variations may exist between boring locations.

1.4 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.

d. Material character is indicated by the boring logs.

f. Hard materials will not be encountered.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Excavation and Trenching Plan; G, RO

Dewatering Work Plan; G, RO

Disposition of Surplus Materials; G, RO

Preconstruction Meeting; G, RO

SD-03 Product Data

Flowable Fill Mix Design; G, RO

Geotextiles

SD-04 Samples

Geotextiles

SD-06 Test Reports

Borrow Site Testing; G, RO

Pipe Inspection Report; G, RO

Material Test Reports; G, RO

1.6 QUALITY CONTROL

1.6.1 Geotechnical Engineer

Provide a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for preparing and updating the Excavation and Trenching Plan and Dewatering Work Plan as construction progresses to reflect changing conditions and submit an updated plan if necessary. The Contractor is responsible for arranging meetings with the Geotechnical Engineer and Contracting Officer throughout the contract duration.

1.6.2 Qualified Technician

Provide a Qualified Technician to inspect, monitor, sample, and performing field testing. The technician qualifications need to be one of the following: a current National Institute for Certification in Engineering Technologies (NICET) Level II minimum certification in Construction Materials Testing Soils; a Geologist-in-Training with minimum one-year experience; an Engineer-in-Training with minimum one-year experience; a Registered Geologist; or a Professional Engineer.

1.6.3 Lab Validation

Perform testing by a Corps validated commercial testing laboratory or Contractor established testing laboratory meeting the requirements of Section 01 45 00 (or similar number) entitled QUALITY CONTROL and approved by the Contracting Officer. Submit testing laboratory validation for the testing to be performed. Do not permit work requiring testing until testing facilities have been inspected, Corps validated and approved by

the Contracting Officer.

1.6.4 Preconstruction Meeting

Conduct a preconstruction meeting at the jobsite at least five business days prior to the start of earthwork operations on the project. The preconstruction meeting is to be arranged by the Contractor and is to follow the written agenda submitted prior to the meeting. The purpose of this meeting is to review the requirements of this specification and the associated plans. The following individuals must be in attendance at this meeting: Contractor's Project Manager and Project Superintendent, earthwork subcontractor's Project Manager and Site Foreman, Contractor's Geotechnical Engineer and Testing Agency, Government Engineer, and Government Construction Manager and Engineering Technician.

The minutes of this meeting are to be recorded by the Contractor and published via email within 48 hours to all attendees. The minutes must be re-published within 48 hours via email pending any subsequent comments from the attendees.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

2.1.1 Structural Fill

Materials classified as SM, SC, or CL in accordance with ASTM D2487. Select material type appropriate for the intended purpose.

2.1.2 Porous Fill

Materials containing less than 5 percent passing the No. 200 sieve. Provide the gradation as appropriate for the intended purpose.

2.1.3 Topsoil

Material suitable for topsoil obtained from areas indicated on the drawings is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Topsoil material will be in accordance with ASTM D5268.

2.1.4 Capillary Water Barrier

Conform to ASTM C33/C33M for fine aggregate grading with Poorly-graded crushed stone or gravel with 100% passing the 1½-inch sieve and less than 5% passing the No. 200 sieve. .

2.1.5 Utility Bedding Material

Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600 or ASTM D2321. Install bedding for plastic piping to spring line of pipe. Utility bedding material may include the following:

2.1.5.1 Class I

Angular, 0.25 to 1.5 inch, graded stone, including a number of fill

materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

2.1.5.2 Class II

Coarse sands and gravels with maximum particle size of 1.5 inch, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

2.1.5.3 Sand

Clean, coarse-grained sand classified as SW or SP by ASTM D2487 for bedding and backfill as indicated.

2.1.5.4 Gravel and Crushed Stone

Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as GW or GP in accordance with ASTM D2487 for bedding and backfill as indicated.

2.2 FLOWABLE FILL

Design and submit flowable fill mix design to consist of Portland cement, fly ash, and/or slag cement and fine aggregate. Include the dry weights of cementitious material(s); quality and gradation of aggregates in the saturated surface-dry weights along with gradation tests; quantities, types, and names of admixtures; and quantity of water per cubic yard. The maximum unconfined compressive strength to be 300 psi at 28 days in accordance with ASTM D4832. The aggregates in accordance with ASTM C33/C33M Fine Aggregates. Air-entrain fill in accordance with ASTM C260/C260M. The air content to be between 8 and 15 percent in accordance with ASTM D6023. Portland cement to be Type I or II in accordance with ASTM C150/C150M. Fly ash to be Class C in accordance with ASTM C618. Provide slag cement in Grade 100 or 120 in accordance with ASTM C989/C989M.

2.3 BURIED WARNING AND IDENTIFICATION MARKERS

Provide polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inches minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes	
Red	Electric
Yellow	Gas, Oil; Dangerous Materials
Orange	Telephone and Other Communications

Warning Tape Color Codes	
Blue	Water Systems
Green	Sewer Systems
White	Steam Systems
Gray	Compressed Air

2.3.1 Warning Tape for Metallic Piping

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.003 inch and a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

2.3.2 Detectable Warning Tape for Non-Metallic Piping

Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.004 inch, and a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.3.3 Detection Wire for Non-Metallic Piping

Insulate a single strand, solid copper detection wire with a minimum of 12 AWG.

2.4 MATERIAL FOR RIP-RAP

Providegeotextile and rock conforming to the 2023 Colorado DOT Specifications for construction indicated.

2.5 BORROW

Provide borrow materials from sources located outside of Government property meeting the requirements of paragraph STRUCTURAL FILL, EMBANKMENT FILL and TOPSOIL.

2.6 GEOTEXTILE

Provide a pervious sheet of nonwoven polyester, nylon, glass or polypropylene ultraviolet resistant filaments, spun bonded, fused, or otherwise manufactured into a non-raveling fabric with uniform thickness and strength. Fabric must have manufacturer certified minimum average roll properties that conform with AASHTO M288 Class 3 Geotextile. Submit a sample and material product data for all Geotextiles utilized.

PART 3 EXECUTION

3.1 PROTECTION

Perform all work specified in accordance with applicable requirements of

the Corps of Engineers publication EM 385-1-1 Safety and Health Requirements Manual. Provide a Geotechnical Engineer to monitor construction activities and to prepare necessary work plans and reports; see paragraph QUALITY CONTROL.

Use equipment of type and size appropriate for the site conditions (soil character and moisture content). Maintenance of exposed subgrades and fills is the responsibility of the Contractor. The Contractor is required to prevent damage by ineffective drainage, dewatering, and heavy loads and equipment by implementing precautionary measures. Repair or replace any defects or damage.

3.1.1 Underground Utilities

Location of the existing utilities indicated is approximate. Physically verify the location and elevation of the existing utilities indicated prior to starting construction. The Contractor is responsible for protecting utilities from damage during construction.

3.1.2 Drainage and Dewatering

Provide for the collection and disposal of surface and subsurface water encountered during construction.

3.1.2.1 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to keep soils from becoming unstable, prevent erosion, or undermining of foundations. Remove unstable material from working platforms for equipment operation and soil support for subsequent construction features and provide new material as specified herein. It is the responsibility of the Contractor to assess the site conditions to employ necessary measures to permit construction to proceed.

3.1.2.2 Dewatering

Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches are not allowed within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Perform control measures by the time the excavation reaches the water level in order to maintain the integrity of the in-situ material. While the excavation is open, maintain the water level continuously, at least 2 feet below the working level. Submit a Dewatering Work Plan outlining procedures for accomplishing dewatering work, if necessary.

3.1.3 Shoring and Sheeting

Submit an Excavation and Trenching Plan to stabilize features, prevent undermining or unintended horizontal and vertical movement of adjacent structures, and prevent slippage or movement in banks or slopes adjacent

to the excavation. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Drawings to include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations are to include data and references used.

3.1.4 Protection of Graded Surfaces

Protect newly backfilled, graded, and topsoiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.2 BORROW

Select borrow material to meet the requirements and conditions of the fill for which it is to be used. Obtain borrow material from from approved private sources. Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling from the owners. Unless specifically provided, do not obtain borrow within the limits of the project site without prior written approval.

3.2.1 Contractor Furnished Borrow Area(s)

Obtain approved borrow materials from approved offsite sources. If a borrow source is selected that is not a commercial entity from which soil material is directly purchased, submit a Borrow Plan that includes the borrow source location, geotechnical test results showing the fill material meets the Contract requirements, environmental test results in accordance with paragraph ENVIRONMENTAL REQUIREMENTS FOR OFF-SITE SOIL, and any Federal, State, and local permits required for excavation and reclamation of the borrow area.

3.2.2 Environmental Requirements for Off-Site Soil

Test offsite soils brought in for use as backfill for PFAS in accordance with Method 1633.
Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and full Toxicity Characteristic Leaching Procedure (TCLP) including ignitability, corrosivity and reactivity. Backfill shall contain amaximum of 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and a maximum of 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall pass the TCPL test. Determine TPH concentrations by using EPA 600/4-79/020 Method 418.1. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5030/8020/8260B. Perform TCLP in accordance with EPA SW-846.3-3 Method 1311. Perform hazardous waste characteristic tests for ignitability, corrosivity, and reactivity in accordance with accepted standard methods. Perform PCB testing in accordance with accepted standard methods for sampling and analysis of bulk solid samples. Provide borrow site testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Do not bring material onsite until tests have been approved by the Contracting Officer.
Submit Test reports prior to soil import.

3.3 SURFACE PREPARATION

3.3.1 Clearing and Grubbing

Remove trees, stumps, logs, shrubs, brush and vegetation and other items that would interfere with construction operations. Remove stumps entirely. Grub out matted roots and roots over 3 inches in diameter to at least 18 inches below existing surface.

3.3.2 Stripping

Strip site where indicated on the plans. Strip existing surface materials and soils to a depth of 6 inches below the existing subgrade surface in all areas. Strip in all areas within the planned limits of disturbance. All stripped materials not suitable for reuse as topsoil will be wasted in specified disposal area. Screen all stripped soils to remove roots and organic materials prior disposal.

3.3.3 Proof Rolling

Perform proof rolling on exposed subgrade that is unfrozen and free of surface water (wet conditions resulting from rainfall).Notify the Contracting Officer a minimum of three days prior to proof rolling. Perform proof rolling in the presence of the Contracting Officer.

After stripping, excavating, and rough grading to the planned elevation, proof roll the existing subgrade of all building and pavement locations with six passes of a loaded tandem axle dump truck or 15 ton, pneumatic-tired or smooth drum roller. Operate the roller or truck in a systematic manner to ensure the number of passes over all areas, and at speeds between 2.5 to 3.5 miles per hour. Subgrade materials that exhibit excessive deflection and/or rutting during proof rolling need to be scarified, aerated, and re-compacted to specified density at plus or minus 2 percent of optimum moisture content prior to being considered for remedial action by the Contracting Officer. When proof rolling under buildings, the building subgrade is considered to extend 5 feet beyond the building lines, and make one-half of the passes with the roller in a direction perpendicular to the other passes.

3.3.4 Stockpiling Operations

Place and grade stockpiles of satisfactory materials as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. Do not create stockpiles that could obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.4 EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Excavate soil disturbed or weakened by Contractor's operations, and soils softened or

made unstable for subsequent construction due to exposure to weather. Use material removed from excavations meeting the specified requirements in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes to minimize surplus material and to minimize additional material to brought on site. Do not excavate below indicated depths except to remove unstable material as determined by the Government and confirmed by the Contracting Officer. Remove and replace excavations below the grades shown with appropriate materials as directed by the Contracting Officer.

If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock or as hard/unyielding material, uncover such material, and notify the Contracting Officer. Do not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow sufficient time for classification and delineation of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

3.4.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown. Do not excavate below grades shown. Backfill excessive excavation as directed by the Contracting Officer, with satisfactory, compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed. Do not allow material to be deposited within 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.4.2 Trench Excavation Requirements

Excavate the trench as recommended by the manufacturer of the pipe to be installed. Slope trench walls below the top of the pipe, or make vertical, and of such width as recommended by the manufacturer. Provide vertical trench walls where no manufacturer installation instructions are available. Do not exceed the trench width of 24 inches below the top pipe plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter, and do not exceed 36 inches plus pipe outside diameter for pipe sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the Government.

3.4.2.1 Bottom Preparation

Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 3 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

3.4.2.2 Removal of Unyielding Material

Where overdepth is not indicated and unyielding material is encountered in the bottom of the trench, notify the Contracting Officer. Following approval, remove such material 6 inches below the required grade and replaced with suitable materials as provided in paragraph FILLING AND COMPACTION.

3.4.2.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with suitable material as provided in paragraph FILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional cost to the Government.

3.4.2.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members.

3.4.2.5 Gas Distribution

Excavate trenches to a depth that will provide a minimum 18 inches of cover in rock excavation and a minimum 24 inches of cover in other excavation.

3.4.2.6 Water Lines

Excavate trenches to a depth that provides a minimum cover of 5.5 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe. For fire protection yard mains or piping, an additional 6 inches of cover is required.

3.4.3 Underground Utilities

Perform work adjacent to utilities in accordance with procedures outlined by utility owner. Excavation made with power-driven equipment is not permitted within 2 feet of known utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.4.4 Structural Excavation

Following general excavation and rough grading activities, excavate the entire building footprint area and at least 3 feet beyond, to 3 feet below the bottom of footings and floor slabs. Scarify the exposed surface to a depth of 6 to 8 inches, moisture-condition, and compact to at least 95 percent of laboratory maximum density. Do not excavate to final grade until just before concrete is to be placed. Roughen level surfaces. Cut

sloped surfaces as indicated into rough steps or benches to provide a satisfactory bond for compacting materials. For new pavement areas including exterior concrete pads, over-excavate to a minimum of 12 inches below bottom of new pavement/pad base course, scarify, moisture-condition, and compact to at least 95 percent.

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata.

Concrete placement is not allowed until footing subgrades have been inspected and approved by the Contracting Officer.

3.5 SUBGRADE PREPARATION

3.5.1 General Requirements

Shape subgrade to line, grade, and cross section as indicated. Remove unsatisfactory and unstable material in surfaces to receive fill or in excavated areas, as determined by proof rolling, and replaced with structural fill. Do not place material on surfaces that are muddy, frozen, contain frost, or otherwise containing unstable material. Scarify the surface to a depth of 6 to 8 inches prior to placing fill. Step or bench sloped surfaces steeper than 1 vertical to 4 horizontal prior to scarifying. Place 4 inches of loose fill and blend with scarified material. When subgrade is part fill and part excavation or natural ground, scarify to a depth of 8 inches.

3.5.2 Subgrade for Structures, Spread Footings, and Concrete Slabs

Do not excavate below depth shown for structures, spread footings, and concrete slabs. If over excavation occurs, notify the Contracting Officer and remove, replace, and compact as directed. compact disturbed material to 95 percent of ASTM D1557. After final rolling, the surface of the subgrade for buildings and pavements must not show deviations greater than 0.05 foot when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area.

3.5.3 Subgrade for Pavements

Compact top 12 inches of subgrade for pavements to at least 95 percent of ASTM D1557. After final rolling, the surface of the subgrade for buildings and pavements must not show deviations greater than 0.05 foot when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area.

3.5.4 Subgrade for Shoulders

Compact the upper 12 inches of subgrade for shoulders to at least 95 percent of ASTM D1557 for the full depth of the shoulder.

3.6 FILLING AND COMPACTION

Prepare ground surface on which backfill is to be placed and provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs for SUBGRADE PREPARATION. Do not place

material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to plus or minus 2 percent of optimum moisture. Fill and backfill to contours, elevations, and dimensions indicated. Compact and test each lift before placing overlaying lift.

3.6.1 Trench Backfill

Backfill trenches to the grade shown. Backfill the trench to 2 feet above the top of pipe prior to performing the required pressure tests. Leave the joints and couplings uncovered during the pressure test.

3.6.1.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the trench with satisfactory material or initial backfill material.

3.6.1.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with satisfactory material placed in layers not exceeding 6 inches loose thickness.

3.6.1.3 Bedding and Initial Backfill

Provide bedding of the type and thickness shown. Place initial backfill material and compact it with approved tampers to a height of at least one foot above the utility pipe or conduit. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Except where shown or when specified otherwise in the individual piping section, provide bedding for buried piping in accordance with PART 2 paragraph UTILITY BEDDING MATERIAL. Compact backfill to top of pipe to 85 percent of ASTM D1557. Provide plastic piping with bedding to spring line of pipe.

3.6.1.4 Final Backfill

Do not begin backfill until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Bring backfill to indicated finish grade. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and one foot above other utility lines need to be free from stones larger than one inch in any dimension. Heavy equipment for spreading and compacting backfill are not to be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; compact remaining area in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Place backfill carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Do not place backfill against foundation walls prior to 7 days after completion of the walls. As far as practicable, bring backfill up evenly on each side of the wall and sloped to drain away from the wall.

Fill the remainder of the trench, except for special materials for buildings and pavements with satisfactory material. Place backfill

material and compact as follows:

3.6.1.4.1 Buildings and Pavements

Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction. Compact as specified for Structural Fill.

3.6.1.4.2 Turfed or Seeded Areas and Miscellaneous Areas

Deposit backfill in layers of a maximum of 12 inches loose thickness, and compact it to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Do not permit compaction by water flooding or jetting. Apply this requirement to all other areas not specifically designated above.

3.6.1.5 Heat Distribution System

Free initial backfill material of stones larger than 1/4 inch in any dimension.

3.6.1.6 Electrical Distribution System

Provide a minimum cover of 24 inches from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.6.1.7 Displacement of Features

After other required tests have been performed and the trench backfill compacted to the finished grade surface, inspect the pipe to determine whether unexpected or damaging displacement has occurred. Conduct walk-through inspection of pipe sizes larger than 48 inches. Inspect pipes smaller than 48 inches using remote methods using closed circuit television, sonar, or hybrid that can provide a 360-degree inspection of the pipe. Prepare and submit a pipe inspection report consisting of digital video or photos. If, in the judgment of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed at no additional cost to the Government.

3.6.1.8 Buried Tape And Detection Wire

3.6.1.8.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.6.1.8.2 Buried Detection Wire

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over its entire length. Install wires at manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, terminate the wire in the valve pit at the pump station end of the pipe.

3.6.2 Structural Fill Placement

Place fill and backfill beneath and adjacent to structures in successive horizontal layers of loose material not more than 8 inches in depth, or in loose layers not more than 4 inches in depth when using hand-operated compaction equipment. Do not place over wet or frozen materials. Compact to at least 95 percent of laboratory maximum density. Perform compaction in such a manner as to prevent wedging action or eccentric loading upon or other damage to the structure. Moisture condition fill and backfill material to within range of plus 2 or minus 2 percent of optimum moisture content at the time of compaction.

3.6.3 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 7 days, place backfill in such a manner that the structure is not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.6.4 Porous Fill Placement

Provide under floor and area-way slabs on a compacted subgrade. Place in a single lift and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.6.5 Flowable Fill

If necessary, place fill in a manner to completely fill voids in the location indicated. Do not place when atmospheric temperatures are expected to be below 33 degrees F at any time during the 3 day period following placement.

3.6.6 Compaction

3.6.6.1 General Site

Compact underneath areas designated for vegetation and areas outside the 5 foot line of the paved area or structure to 90 percent of ASTM D1557.

3.6.6.2 Adjacent Areas

Compact areas within 5 feet of structures to 95 percent of ASTM D1557.

3.7 RIP-RAP CONSTRUCTION

Construct rip-rap on geotextile fabric in accordance with State of Colorado DOT Specifications in the areas indicated. Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 0.1 foot.

3.7.1 Geotextile Placement

Spread geotextile fabric on prepared subgrade as indicated and per manufacturer specifications.required.

3.7.2 Stone Placement

Place rock for rip-rap on geotextile fabric to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above.

3.8 FINISHING/FINISH OPERATIONS

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. Protect and maintain the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, frozen or otherwise unstable subgrade.

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except as indicated for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.8.1 Capillary Water Barrier

Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.8.2 Grading Around Structures

Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.8.3 Shoulder Construction

Construct shoulders of structural fill. Submit advanced notice on shoulder construction for rigid pavements. Construct shoulders immediately after adjacent paving is complete. In the case of rigid pavements, do not construct shoulders until permission of the Contracting Officer has been obtained. Compact the entire shoulder area to at least the percentage of maximum density as specified in paragraph SUBGRADE PREPARATION above, for specific ranges of depth below the surface of the shoulder. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Finish shoulder construction in proper sequence in such a manner that adjacent ditches will be drained effectively and that no

damage of any kind is done to the adjacent completed pavement. Align the completed shoulders true to grade and shaped to drain in conformity with the cross section shown.

3.8.4 Grading

Finish grades as indicated within one-tenth of one foot. Grade areas to drain water away from structures. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

3.8.5 Topsoil and Seed

On areas to receive topsoil, prepare the compacted subgrade soil to a 2 inches depth for bonding of topsoil with subsoil. Spread topsoil evenly to a thickness of 4 inches and grade to the elevations and slopes shown. Do not spread topsoil when frozen or excessively wet or dry. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inches in diameter, and other materials that would interfere with planting and maintenance operations. Remove from the site any surplus of topsoil from excavations and gradings. Obtain material required for topsoil in excess of that produced by excavation within the grading limits from offsite areas.

3.9 DISPOSITION OF SURPLUS MATERIAL

Remove from Government property all surplus or other soil material not required or not suitable for filling or backfilling, along with brush, refuse, stumps, roots, and timber. Properly disposed of in accordance with all applicable laws and regulations. Prepare plan for Disposition of Surplus Materials to include permissions document to dispose of nonsalable products.

3.10 TESTING

Submit Material Test Reports within 24 hours of tests being completed. Perform testing by a Corps validated commercial testing laboratory or the Contractor's validated testing facility. Submit qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, Corps validated and approved by the Contracting Officer.

a. Determine field in-place density in accordance with ASTM D1556/D1556M ASTM D2167 or ASTM D6938.

b. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements.

c. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. State that the

tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.10.1 Fill and Backfill Material Gradation

One test per 500 cubic yards stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM C136/C136M or ASTM D1140.

3.10.2 In-Place Densities

a. One test per 2,500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 500 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per 1,000 linear feet, or fraction thereof, of each lift of embankment or backfill for roads.

3.10.3 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

3.10.4 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

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DIVISION 31 - EARTHWORK

SECTION 31 11 00

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SECTION 31 11 00

CLEARING AND GRUBBING
11/18

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Tree Wound Paint

1.2 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the site, and handle in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Tree Wound Paint

Use bituminous based paint from standard manufacture specially formulated for tree wounds.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

3.1.1.1 Roads and Walks

Keep roads and walks free of dirt and debris at all times.

3.1.1.2 Trees, Shrubs, and Existing Facilities

Provide protection in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION. Protect trees and vegetation to be left standing from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.

3.1.1.3 Utility Lines

Protect existing utility lines that aren't indicated to be removed from damage. Notify the Contracting Officer immediately of damage to or an encounter with an unknown existing utility line. The Contractor is

responsible for the repair of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, notify the Contracting Officer in ample time to minimize interruption of the service. Refer to Section 01 30 00.24 OTHER ADMINISTRATIVE AND SPECIAL REQUIREMENTS and Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION for additional utility protection.

3.2 CLEARING

Clearing consists of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. Clearing also includes the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work. Cut off flush with or below the original ground surface trees, stumps, roots, brush, and other vegetation in areas to be cleared, except such trees and vegetation as may be indicated or directed to be left standing. Trim dead branches 1-1/2 inches or more in diameter on trees designated to be left standing within the cleared areas and trim all branches to the heights indicated or directed. Neatly cut close to the bole of the tree or main branches, limbs and branches to be trimmed. Paint, with an approved tree-wound paint, cuts more than 1-1/2 inches in diameter. Apply herbicide to the top surface of stumps designated not to be removed.

3.2.1 Tree Removal

Where indicated or directed, remove trees and stumps that are designated as trees from areas outside those areas designated for clearing and grubbing. This work includes the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING. Dispose of trees as specified in paragraph DISPOSAL OF MATERIALS.

3.2.2 Grubbing

Grubbing consists of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas. Remove material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Fill depressions made by grubbing with suitable material and compact to make the surface conform with the original adjacent surface of the ground.

3.3 DISPOSAL OF MATERIALS

Dispose of excess materials in accordance with the approved solid waste management permit and include those materials in the solid waste management report.

All wood or wood like materials, except for salable timber, remaining from clearing, prunning or grubbing such as limbs, tree tops, roots, stumps, logs, rotten wood, and other similiar materials is the property of the Contractor and dispose of as specified. All non-saleable timber and wood or wood like materials remaining from timber harvesting such as limbs, tree tops, roots, stumps, logs, rotten wood, and other similiar materials

is the property of the Contractor and dispose of as specified.

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SECTION 32 01 19.61

SEALING OF JOINTS IN RIGID PAVEMENT
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C603	(2014; R 2019) Standard Test Method for Extrusion Rate and Application Life of Elastomeric Sealants
ASTM C639	(2015; R 2020)Standard Test Method for Rheological (Flow) Properties of Elastomeric Sealants
ASTM C661	(2015; R 2022) Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer
ASTM C679	(2015; R 2022) Standard Test Method for Tack-Free Time of Elastomeric Sealants
ASTM C719	(2014; R 2019) Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
ASTM C792	(2023) Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants
ASTM C793	(2023) Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants
ASTM C1016	(2014; R 2022) Standard Test Method for Determination of Water Absorption of Sealant Backing (Joint Filler) Material
ASTM D789	(2015) Determination of Relative Viscosity and Moisture Content of Polyamide (PA)
ASTM D903	(1998; R 2017) Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
ASTM D5249	(2010; R 2016) Standard Specification for Backer Material for Use with Cold-and Hot-Applied Joint Sealants in

	Portland-Cement Concrete and Asphalt Joints
ASTM D5893/D5893M	(2016) Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
ASTM D6690	(2021) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants; G, RO

Submit catalog cuts, specifications, Safety Data Sheets and other information documenting conformance to Contract requirements.

Manufacturer's Recommendations

SD-04 Samples

Sealants

Provide for testing a 5-gal sample of each sealant with associated primer to the Contracting Officer a minimum of 60 days prior to its use on the job. Provide factory-sealed containers with a factory applied label showing the following information:

Name of sealant

Identification of component, or primer

Specification number and type

Manufacturer's name

Manufacturer's lot and batch number

Date of Manufacture (month and year)

Shelf life retest date (month and year)

List of hazardous components

Quantity of material in container (volume)

Storage instructions

Instructions for use

Blocking Media/Backup Materials

Backer Rod

Bond Breaking Tapes

SD-06 Test Reports

Sealants

SD-07 Certificates

Equipment List

SD-08 Manufacturer's Instructions

Sealants

Provide instructions that include, but not limited to: storage requirements, ambient temperature and humidity ranges, and moisture condition of joints for successful installation; requirements for preparation of joints; safe heating temperature; mixing instructions; installation equipment and procedures; application and disposal requirements; compatibility of sealant with filler material; curing requirements; and restrictions to be adhered to in order to reduce hazards to personnel or to the environment. Submit instructions at least 30 days prior to use.

1.3 QUALITY ASSURANCE

1.3.1 Test Requirements

Test the sealant and backup or separating material for conformance with the referenced material specification. Perform testing of the materials in an approved independent laboratory and submit certified copies of the test reports for approval 30 days prior to the use of the materials at the job site. Submit samples to be retained by the Government for possible future testing if the materials appear defective during or after application. Conformance with the requirements of the laboratory tests specified does not constitute final acceptance of the materials. Base final acceptance on the performance of the in-place materials. Submit samples of the materials (sealant, primer if required, and backup material), in sufficient quantity for testing and approval 30 days prior to the beginning of work. Do not use material until it has been approved.

1.3.2 Trial Joint Sealant Installation

Prior to cleaning and sealing the joints for the entire project, prepare a test section at least 200 ft long using the specified materials and approved equipment, so as to demonstrate the proposed joint preparation and sealing of the types of joints in the project. Following the completion of the test section and before any other joint is sealed, inspect the test section to determine that the materials and installation meet the requirements specified. Inspect joint seal test section. Correct deficiencies and obtain approval of test section prior to installing joint seals. If it is determined that the materials or installation do not meet the requirements, remove the materials, and

reclean and reseal the joints at no cost to the Government. Permit the test section meeting the requirements to be incorporated into the permanent work and paid for at the Contract unit price per linear foot for sealing items scheduled. Prepare and seal other joints in the manner approved for sealing the test section. Notify the Contracting Officer upon completion of the test section.

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for visible damage, and unload and store with a minimum of handling. Deliver joint materials in original sealed containers and protect from freezing or overheating. Provide jobsite storage facilities capable of maintaining temperature ranges within manufacturers recommendations.

1.5 ENVIRONMENTAL REQUIREMENTS

Do not proceed with work when weather conditions detrimentally affect the quality of cleaning joints or applying sealants. Proceed with joint preparation and sealing only when weather conditions are in accordance with manufacturer's instructions. Install joint sealant to dry surfaces and protect sealant and bond breakers from moisture.

1.6 TRAFFIC CONTROL

Do not permit vehicular or heavy equipment traffic on the pavement in the area of the joints being sealed during the protection and curing period of the sealant. Permit traffic on the pavement at the end of the curing period.

PART 2 PRODUCTS

2.1 SEALANTS

Use materials for sealing cracks and joints in accordance with ASTM D5893/D5893M based on the type of area as follows:

Area	Sealing Material
All	ASTM D5893/D5893M

Use self leveling, non-acid curing silicone sealant that is recommended by the manufacturer for exposure to diesel in secondary containment applications, and meets the following requirements:

TEST	TEST METHOD	REQUIREMENTS
Weight Loss	ASTM C792 Modified (see Note 1 below)	10 percent max.

TEST	TEST METHOD	REQUIREMENTS
Flow	ASTM C639 (Type I)	Smooth and level
Extrusion Rate	ASTM C603	30 sec. max.
Tack Free Time	ASTM C679	5 hours max.
Hardness (Shore 00) (see Note 2 below)	ASTM C661	30 - 80
Accelerated Weathering	ASTM C793	Pass 5000 hours
Bond and Movement Capability	ASTM C719	Pass 10 cycles at plus 50 percent movement (no adhesion or cohesion failure)
Peel	ASTM D903	Minimum 20 psi of width with at least 75 percent cohesive failure

NOTES:
1. Percent weight loss of wet (uncured) sample after placing in forced-draft oven maintained at 158 degrees plus 1 degree F for two hours.

2. Specimen cured 21 days at 73 degrees plus 1 degree F and 50 percent plus 5 percent humidity.

ACCELERATED WEATHERING FACTORY TEST REPORT. For the Accelerated Weathering test, in lieu of testing of actual sealant to be used on the project, it is permitted to submit a report of a factory test, performed within two years of Contract award.

2.2 PRIMERS

Use primers in accordance with the recommendation of the manufacturer.

2.3 BOND BREAKERS

2.3.1 Blocking Media/Backup Materials

Provide backup (joint filler) material that is a compressible, nonshrinking, nonstaining, nonabsorbing, nonreactive material with the sealant. Use backup material compliant with ASTM D5249. Use material with a melting point at least 5 degrees F greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. Use material with a water absorption of not more than 5 percent of the sample weight when tested in accordance with ASTM C1016. Use backup (joint filler) material that is 25 plus or minus 5 percent larger in diameter than the nominal width of the crack. Use blocking media consistent with the sealant manufacturer's installation instructions.

2.3.2 Bond Breaking Tapes

Provide a bond breaking tape or separating material that is a flexible, nonshrinkable, nonabsorbing, nonstaining, and nonreacting adhesive-backed tape. Use material with a melting point at least 5 degrees F greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. Use bond breaker tape approximately 1/8 in wider than the nominal width of the joint and that does not bond to the sealant. Use bond breaking tape consistent with the sealant manufacturer's installation instructions.

PART 3 EXECUTION

3.1 EXECUTING EQUIPMENT

Submit equipment list and description of the equipment to be used and a statement from the supplier of the sealant that the proposed equipment is acceptable for installing the specified sealant. Use equipment for heating, mixing, and installing seals in accordance with the instructions provided by the sealant manufacturer. Provide equipment, tools, and accessories necessary to clean existing joints and install liquid joint sealants. Maintain machines, tools, and other equipment in proper working condition. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, 30 days prior to use on the project.

3.1.1 Joint Cleaning Equipment

3.1.1.1 Tractor-Mounted Routing and Plowing Tool

Use routing tools for removing old sealant from the joints, of such shape and dimensions and so mounted on the tractor that do not damage the sides of the joints. Use tools designed to be adjusted to remove the old material to varying depths and widths as required. Use equipment capable of maintaining accurate cutting depth and width control. Use a joint plow equipped with a spring or hydraulic mechanism to release pressure on the tool prior to spalling the concrete. Do not permit the use of V-shaped tools or rotary impact routing devices. Permit the use of hand-operated spindle routing devices to clean and enlarge random cracks.

3.1.1.2 Concrete Saw

Provide a self-propelled power saw, with water-cooled diamond or abrasive saw blades, for cutting joints to the depths and widths specified, for refacing joints, cleaning sawed joints where sandblasting does not provide a clean joint, widening, or deepening existing joints as specified without damaging the sides, bottom, or top edge of joints. Permit single or gang type blades with one or more blades mounted in tandem for fast cutting. Select saw adequately powered and sized to cut specified opening with not more than two passes of the saw through the joint.

3.1.1.3 Sandblasting Equipment

Include with the sandblasting equipment an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. Do not permit the maximum nozzle opening to exceed 1/4 in. Use a portable air compressor capable of providing not less than 150 cfm and maintaining a line pressure of not less than 90 psi at the nozzle while in use.

Demonstrate compressor capability, under job conditions, before approval. Use a compressor equipped with traps that maintain the compressed air free of oil and water. Use a nozzle with an adjustable guide that holds the nozzle aligned with the joint approximately 1 in above the pavement surface. Adjust the height, angle of inclination and the size of the nozzle to secure satisfactory results.

3.1.1.4 Waterblasting Equipment

Include with the waterblasting equipment a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment. Provide water tank and auxiliary resupply equipment of sufficient capacity to permit continuous operations. Use a nozzle with an adjustable guide that holds the nozzle aligned with the joint approximately 1 in above the pavement surface. Adjust the height, angle of inclination and the size of the nozzle to obtain satisfactory results. Use a pressure gauge mounted at the pump that shows the pressure in psi at which the equipment is operating.

3.1.1.5 Air Compressor

Use a portable air compressor capable of operating the sandblasting equipment and capable of blowing out sand, water, dust adhering to sidewalls of concrete, and other objectionable materials from the joints. Use a compressor that provides air at a pressure not less than 90 psi and a minimum rate of 150 cubic ft of air per minute at the nozzles and free of oil.

3.1.1.6 Vacuum Sweeper

Use a self-propelled, vacuum pickup sweeper capable of completely removing loose sand, water, joint material, and debris from pavement surface.

3.1.1.7 Hand Tools

Permit the use of hand tools, such as brooms and chisels, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces.

3.1.2 Sealing Equipment

Use joint sealing equipment of a type required by the sealant manufacturer's installation instructions. Use equipment capable of installing sealant to the depths, widths and tolerances indicated. Do not proceed with joint sealing when malfunctions are noted until the malfunctions are corrected.

3.1.2.1 Hot-Poured Sealing Equipment

Use mobile unit applicators equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer for heating and installing ASTM D6690 joint sealant materials; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording thermometer for indicating the temperature of the sealant. Use an applicator unit designed so that the sealant circulates through the delivery hose and returns to the inner kettle when not in use.

3.1.2.2 Cold-Applied, Single-Component Sealing Equipment

Use equipment for installing ASTM D5893/D5893M single component joint sealants that consists of an extrusion pump, air compressor, following plate, hoses, and nozzle for transferring the sealant from the storage container into the joint opening. Use a nozzle with dimensions that allows the tip of the nozzle to extend into the joint to allow sealing from the bottom of the joint to the top. Maintain the initially approved equipment in good working condition, serviced in accordance with the supplier's instructions, and unaltered in any way without obtaining prior approval. Use lined hoses and seals to prevent moisture penetration and withstand pumping pressures. Use equipment free of contamination from previously used or other type sealant. Permit use of small hand-held air-powered equipment (i.e., caulking guns) for small applications.

3.2 SAFETY

Do not place sealant within 25 ft of LOX equipment, LOX storage, or LOX piping. Clean joints in this area and leave them unsealed.

In accordance with the provisions of the Contract respecting "Accident Prevention," take appropriate measures to control worker exposure to toxic substances during the work. Provide personnel protective equipment as required. Make Material Safety Data Sheets (Department of Labor Form OSHA-20 or comparable form) available on the site.

3.3 PREPARATION OF JOINTS

Unless otherwise indicated, remove existing material, saw, clean and reseal joints. Do not proceed with final cleaning operations by more than one working day in advance of sealant. Clean joints by removing existing joint sealing compound, bond-breakers, dirt, laitance, curing compound, filler, and protrusions of hardened concrete from the sides and upper edges of the joint space to be sealed and other foreign material with the equipment. Do not permit cleaning procedures that damage joints or previously repaired patches by chipping or spalling. Remove existing sealant to the required depth. Precise shape and size of existing joints vary, and conditions of joint walls and edges vary and include but are not limited to rounding, square edges, sloping, chips, voids, depressions, and projections.

3.3.1 Existing Sealant Removal

Cut loose the in-place sealant from both joint faces and to the required depth, using theconcrete saw as specified in paragraph EQUIPMENT. Provide a depth sufficient to accommodate blocking media and bond breakers that are required to maintain the depth of new sealant to be installed. For expansion joints, remove existing sealant to a depth of not less than 1 in. When existing preformed expansion-joint material is more than 1 in below the surface of the pavement, remove existing sealant to the top of the preformed joint filler. Prior to further cleaning operations, remove loose old sealant remaining in the joint opening by blowing with compressed air. Permit use of hand tools to remove sealant from random cracks. Do not permit chipping, spalling, or other damage to the concrete. Clean pavement surface with vacuum sweeper. Protect previously cleaned joints from being contaminated by subsequent cleaning operations.

3.3.2 Sawing

3.3.2.1 Facing of Joints

Accomplish facing of joints using a concrete saw as specified in paragraph EQUIPMENT to saw through sawed and filler-type joints to loosen and remove material until the joint is clean and open to the full specified width and depth. Provide exposure of newly clean concrete through removal. Remove burrs and irregularities from sides of joint faces. Stiffen the blade with a sufficient number of dummy (used) blades or washers. Clean, immediately following the sawing operation, the joint opening using a water jet to remove saw cuttings and debris and adjacent concrete surface. Protect adjacent previously cleaned joint spaces from receiving water and debris during the cleaning operation.

a. Joint Widening (Except Expansion Joints): Saw joints having grooves less than 3/8 in wide and less than 1 in deep to a minimum width of 1/2 in and to the minimum depth, 1 in.

3.3.2.2 Refacing of Random Cracks

Accomplish sawing of the cracks using a power-driven concrete saw as specified in paragraph EQUIPMENT. Use a saw blade 6 in or less in diameter to enable the saw to follow the trace of the crack. Stiffen the blade with dummy (or used) blades or washers. Immediately following the sawing operation, clean the crack opening using a water jet to remove saw cuttings and debris.

3.3.3 Final Cleaning of Joints

3.3.3.1 Sandblasting

Following removal of existing sealant, and sawing, and immediately before resealing, clean newly exposed concrete joint faces and pavement surface extending to a mimimum of 1/2 in up to 2 in from each joint edge by sandblasting until concrete surfaces in the joint space are free of sealants, dust, dirt, water and other foreign materials that prevent bonding of new sealants to the concrete. Use sand particles of the proper size and quality for the work. Perform sandblasting with specified nozzles, air compressor, and other appurtenant equipment. Position nozzles to clean the joint faces. Make at least two passes; one for each joint face. Make as many passes as required for proper cleaning. Immediately prior to sealing the joint, blow out the joint spaces with compressed air until completely free of sand, water, and dust. Install joint sealants to dry joints. Replace expansion joint filler material damaged in performing the work with new materials of the same type and dimensions as the existing material, or with appropriate blocking media.

3.3.4 Bond Breaker

At the time the joints receive the final cleaning and are dry, install bond breaker material as indicated with a steel wheel or other approved device.

3.3.4.1 Blocking Media (Backer Rod) (Except for Expansion Joints)

When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using a blocking media/back-up material to prevent the entrance of the

sealant below the specified depth. Take care to ensure that the blocking media/backup material is placed at the specified depth and is not stretched or twisted during installation.

3.3.4.2 Bond Breaking Tape

Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond breaker separating tape to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Bond the tape to the bottom of the joint opening to prevent it from floating up into the new sealant.

3.3.5 Rate of Progress of Joint Preparation

Limit the stages of joint preparation, including sandblasting, air pressure cleaning and placing of the back-up material to only that lineal footage that can be sealed during the same day.

3.3.6 Disposal of Debris

Sweep pavement surface to remove excess joint material, dirt, water, sand, and other debris by vacuum sweepers or hand brooms. Remove the debris immediately to a designated area.

3.4 PREPARATION OF SEALANT

3.4.1 Hot-Poured Sealants

Heat hot-poured sealing materials in accordance with ASTM D6690 and with safe heating temperature ranges recommended by the manufacturer. Withdraw and waste sealant that has been overheated or subjected to heating for over 3 hours or that remain in the applicator at the end of the day's operation. Heat sealant in specified equipment.

3.4.2 Single-Component, Cold-Applied Sealants

Inspect the ASTM D5893/D5893M sealant and containers prior to use. Reject materials that contain water, hard caking of any separated constituents, nonreversible jell, or materials that are otherwise unsatisfactory. Do not reject sealants that exhibit settlement of constituents in a soft mass that can be readily and uniformly remixed in the field with simple tools.

3.5 INSTALLATION OF SEALANT

3.5.1 Time of Application

After approval of the test section, seal joints immediately following final cleaning and placing of bond breakers. Commence sealing joints when walls are dust free and dry, and when weather conditions meet sealant manufacturer's instructions. If the above conditions cannot be met, or when rain interrupts sealing operations, reclean and permit the joints to dry prior to installing the sealant.

3.5.2 Sealing Joints

Do not install joint sealant until joints to be sealed have been inspected and approved. Install bond breaker just prior to pouring sealant. Fill the joints with sealant from bottom up until joints are uniformly filled

solid from bottom to top using the specified equipment for the type of sealant required. Fill joints to 1/4 in plus or minus 1/16 in below top of pavement, and without formation of voids or entrapped air. Do not permit gravity methods or pouring pots to be used to install the sealant material. Except as otherwise permitted, tool the sealant immediately after application to provide firm contact with the joint walls and to form the indicated sealant profile below the pavement surface. Remove excess sealant that has been inadvertently spilled on the pavement surface. Do not permit traffic over newly sealed pavement until authorized. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's recommendations. Check sealed joints frequently to ensure that newly installed sealant is cured to a tack-free condition within the specified time. Protect new sealant from rain during curing period.

3.6 INSPECTION/FIELD QUALITY CONTROL

3.6.1 Joint Cleaning

Inspect joints during the cleaning process to correct improper equipment and cleaning techniques that damage the concrete pavement in any manner. Approve cleaned joints prior to installation of the separating or back-up material and joint sealant.

3.6.2 Sampling Sealant

Obtain a one gal sample of each type of sealant on the project from material used for each 10,000 linear ft or less of joints sealed. Store samples according to sealant manufacturer's instructions. Retain samples until final acceptance of the work.

3.6.3 Sealant Application Equipment

Inspect the application equipment to ensure conformance to temperature requirements, proper proportioning and mixing (if two-component sealant) and proper installation. Suspend operations if there is evidences of bubbling, improper installation, or failure to cure or set until causes of the deficiencies are determined and corrected.

3.6.4 Joint Sealant

Inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Remove sealants exhibiting these deficiencies prior to the final acceptance of the project from the joint, wasted, and replace at no additional cost to the Government. Obtain approval for each joint seal installation.

3.7 ACCEPTANCE

Reject sealer that fails to cure properly, or fails to bond to joint walls, or reverts to the uncured state, or fails in cohesion, or shows excessive air voids, blisters, surface defects, swelling, or other deficiencies, or is not properly recessed within indicated tolerances. Remove rejected sealer and reclean and reseal joints. Perform removal and

reseal work promptly by and at the expense of the Contractor.

3.8 CLEAN-UP

Upon completion of the project, remove unused materials from the site and leave the pavement in a clean condition.

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SECTION 32 05 33

LANDSCAPE ESTABLISHMENT
08/17

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 Pesticide

Any substance or mixture of substances, including biological control agents, that may prevent, destroy, repel, or mitigate pests and are specifically labeled for use by the U.S. Environmental Protection Agency (EPA). Also, any substance used as a plant regulator, defoliant, disinfectant, or biocide. Examples of pesticides include fumigants, herbicides, insecticides, fungicides, nematicides, molluscicides and rodenticides.

1.1.2 Planter Beds

A planter bed is defined as an area containing one or a combination of the following plant types: shrubs, vines, wildflowers, annuals, perennials, ground cover, and a mulch topdressing excluding turf. Trees may also be found in planter beds.

1.2 RELATED REQUIREMENTS

Section 32 92 19 SEEDING applies to this section for installation of seed requirements, with additions and modifications herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Integrated Pest Management Plan; G, RO

SD-03 Product Data

Fertilizer; G, RO

Mulches Topdressing; G, RO

Organic Mulch Materials; G, RO

SD-07 Certificates

Maintenance Inspection Report; G, RO

1.4 DELIVERY, STORAGE AND HANDLING

1.4.1 Delivery

Deliver fertilizer to the site in original containers bearing manufacturer's chemical analysis, name, trade name, or trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer may be furnished in bulk with a certificate indicating the above information.

1.4.2 Storage

1.4.2.1 Fertilizer and Mulch Storage

Store material in designated areas. Store fertilizer in cool, dry locations away from contaminants.

1.4.2.2 Antidesiccant's Storage

Do not store with fertilizers or other landscape maintenance materials.

1.4.3 Handling

Do not drop or dump materials from vehicles.

PART 2 PRODUCTS

2.1 POST-PLANT FERTILIZER

2.1.1 Granular Fertilizer

Organic, granular controlled release NPK fertilizer containing percentages, by weight, of plant food nutrients based on results of soil testing.
Organic, granular controlled release NPK fertilizer containing percentages, by weight, of plant food nutrients based on results of soil testing.2.2 WATER

Source of water must be approved by the Contracting Officer, and be of suitable quality for irrigation.

2.3 MULCHES TOPDRESSING

Free from noxious weeds, mold, or other deleterious materials.

2.3.1 Organic Mulch Materials

Provide wood cellulose fiber, wood chips, or shredded hardwood. Wood cellulose fiber must be processed to contain no growth or germination-inhibiting factors, dyed with non-toxic, biodegradable dye to an appropriate color to facilitate visual metering of materials application. Paper-based hydraulic mulch must contain a minimum of 100 percent post-consumer recycled content. Wood-based hydraulic mulch must contain a minimum of 100 percent total recovered materials content.

2.3.2 Recycled Organic Mulch

Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 2-1/2 by 2-1/2 inch screen. Clean recycled mulch of all sticks a minimum one inch in diameter and plastic materials a minimum 3 inch length. The material must be treated to retard the growth of mold and fungi.

2.4 PESTICIDES

Pesticides and herbicides are not permitted unless submitted for approval to the Government and Sponsor.Submit an Integrated Pest Management Plan, including weed and pest management strategies and proposed herbicides and pesticides. Use biological pest controls as approved in the Plan.

PART 3 EXECUTION

3.1 EXTENT OF WORK

Provide landscape construction maintenance to include mowing, edging, overseeding, fertilizing, watering, and weeding for all newly installed or renovated landscape areas and existing plant material, unless indicated otherwise, and at all areas inside or outside the limits of the construction that are disturbed by the Contractor's operations.

3.1.1 Policing

Police all landscaped areas. Policing includes removal of leaves, branches and limbs regardless of length or diameter, dead vegetation, paper, trash, cigarette butts, garbage, rocks or other debris. Collected debris must be promptly removed and disposed of at an approved disposal site.

3.1.2 Drainage System Maintenance

Remove all obstructions from surface and subsurface drain lines to allow water to flow unrestricted in swales, catch basins, and yard drains. Remove grates and clear debris in catch basins. Open drainage channels are to be maintained free of all debris and vegetation at all times. Edges of these channels must be clear of any encroachment by vegetation.

3.2 GROUNDCOVER ESTABLISHMENT PERIOD

Groundcover establishment period will commence on the date that inspection by the Contracting Officer shows that the new seed mixes furnished under this contract has been satisfactorily installed to a 95 percent stand of coverage with no gaps in coverage larger than one and a half (1.5') feet in a single given area. The establishment period must continue for a period of 365 days.

3.2.1 Frequency of Maintenance

Begin maintenance immediately after seeding. Inspect areas once a week during the installation and establishment period and perform needed maintenance promptly.

3.2.2 Promotion of Growth

Maintain groundcover in a manner that promotes proper health, growth,

natural color. Mow, remove excess clippings, eradicate weeds, water, fertilize, overseed, and perform other operations necessary to promote growth, as approved by Contracting Officer and consistent with approved Integrated Pest Management Plan. Remove noxious weeds common to the area from planting areas by mechanical means.

3.2.3 Mowing

3.2.3.1 Native Grasses

Mow above height of native grass seedlings (approximately 3.5 to 4 inches). Mow during spring or early summer. Do not mow after early summer during the second growing season.

3.2.3.2 Wildflowers

Mow three times per season above height of the wildflowers (approximately 12 to 15 inches).

3.2.4 Edging and Trimming

Perimeter of planter bed edges, sidewalks, driveways, curbs, and other paved surfaces must be edged. Uniformly edge these areas to prevent encroachment of vegetation onto paved surfaces and to provide a clear cut division line between planter beds, turf, and ground cover. Edging is to be accomplished in a manner that prevents scalping, rutting, bruising, uneven and rough cutting. Perform edging on the same day that planted area is mowed. Use of string line trimmers is permitted in "soft" areas such as an edge between turfgrass and a planter bed. Exercise care to avoid damage to any plant materials, structures, and other landscape features.

Trimming around trees, fences, poles, walls, and other similar objects is to be accomplished to match the height and appearance of surrounding growth. Care must be exercised to avoid "Girdling" trees located in turf areas. The use of protective tree collars on trees in turf areas may be utilized as a temporary means to avoid injury to tree trunks. At the end of the plant establishment period Contractor will be responsible for removing all protective tree collars.

3.2.5 Post-Fertilizer Application

Apply turf fertilizer in a manner that promotes health, growth, vigor, color and appearance of cultivated turf areas. The method of application, fertilizer type and frequencies must be determined by the laboratory soil analysis results the requirements of the particular turf species. Apply fertilizer by approved methods in accordance with the manufacturer's recommendations.

3.2.6 Turf Watering

Perform irrigation in a manner that promotes the health, growth, color and appearance of cultivated vegetation and that complies with all Federal, State, and local water agencies and authorities directives. The Contractor must be responsible to prevent over watering, water run-off, erosion, and ponding due to excessive quantities or rate of application. Abide by state, local or other water conservation regulations or restrictions in force during the establishment period..

3.2.7 Replanting

Replant in accordance with Section 32 92 19 SEEDING and within specified planting dates areas which do not have a satisfactory stand of native grasses and wildflowers.

3.2.8 Final Inspection and Acceptance

Final inspection will be make upon written request from the Contractor at least 10 days prior to the last day of the turf establishment period. Final turf acceptance will be based upon a satisfactory stand of turf.

3.3 FIELD QUALITY CONTROL

3.3.1 Maintenance Inspection Report

Provide maintenance inspection report to assure that landscape maintenance is being performed in accordance with the specifications and in the best interest of plant growth and survivability. Site observations must be documented at the start of the establishment period, then quarterly following the start, and at the end of establishment period. Submit results of site observation visits to the Contracting Officer within 7 calendar days of each site observation visit.

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(COLORADO) PAVEMENTS FOR SMALL PROJECTS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

STATE DEPARTMENT OF HIGHWAYS, DIVISION OF HIGHWAYS, STATE OF COLORADO (CDOT)

CDOT	Standard Specifications for Road and Bridge Construction, 2005 Edition
CP 44	(2005) Bulk Specific Gravity and Percent Relative Compaction of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
CP 48	(1998) Determination of the Voids in the Mineral Aggregate (VMA)
CP 51	(1998) Determining the Maximum Specific Gravity of Bituminous Mixtures
CP 75	(2001) Stratified Random Sampling of Materials
CP-L 4211	(2005) Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
CP-L 5115	(2005) Preparing and Determining the Density of Bituminous Mixture Test Specimens Compacted by the Superpave Gyratory Compactor

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	(2020) Specifications for Structural Concrete

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 104	(1999; R 2007) Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate

AASHTO T 180	(2017) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

ASTM INTERNATIONAL (ASTM)

ASTM A 185/A 185M	(2007) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM C 31/C 31M	(2009) Making and Curing Concrete Test Specimens in the Field
ASTM C 39/C 39M	(2009a) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94/C 94M	(2009) Ready-Mixed Concrete
ASTM C 136	(2006) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143/C 143M	(2009) Slump of Hydraulic Cement Concrete
ASTM C 150	(2007) Portland Cement
ASTM C 172	(2008) Sampling Freshly Mixed Concrete
ASTM C 174/C 174M	(2006) Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C 192/C 192M	(2007) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(2009b) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 566	(1997; R 2004) Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 881/C 881M	(2002) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 1077	(2009b) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1260	(2007) Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM D 1461	(1985; R 2006) Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D 1557	(2007) Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft-lbf/ft (2,700 kN-m/m))
ASTM D 2172	(2005) Quantitative Extraction of Bitumen

	from Bituminous Paving Mixtures
ASTM D 3405	(1997) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements
ASTM D 3666	(2009a) Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D 4125	(2005) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D 4867/D 4867M	(2009) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D 5444	(2008) Mechanical Size Analysis of Extracted Aggregate
ASTM D 5821	(2001; R 2006) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D 5893	(2004) Cold Applied, Single Component Chemically Curing Silicon Joint Sealant for Portland Cement Concrete Pavement
ASTM D 6307	(2005) Asphalt Content of Hot Mix Asphalt by Ignition Method

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 525	(1989) Corps of Engineers Test Method for Evaluation of Hot-Applied Joint Sealants for Bubbling Due to Heating

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000) Concrete Plant Standards

1.2 MEASUREMENT AND PAYMENT

Section "MEASUREMENT AND PAYMENT" and paragraphs "METHOD OF MEASUREMENT" and "BASIS OF PAYMENT" of the CDOT shall not apply.

1.3 MODIFICATION TO THE CDOT

Reference to "Engineer" and "Department" in the CDOT shall mean the Contracting Officer or Representative.

1.4 CDOT STANDARD SPECIAL PROVISIONS

The 2005 CDOT shall be revised in accordance with the Standard Special Provisions current at the time of project advertisement.

1.5 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.5.1 Degree of Compaction

Degree of compaction of aggregate base course, rigid pavement base course, subbase course, and aggregate surface course shall be expressed as a percentage of the maximum density obtained by the test procedure presented in either ASTM D 1557 or AASHTO T 180, Method D. The maximum density shall be determined in accordance with ASTM D 1557 if the material gradation contains less than 30 percent retained on the 3/4 inch sieve or AASHTO T 180 if the material gradation contains more than 30 percent retained on the 3/4 inch sieve. In this specification, degree of compaction shall be a percentage of laboratory maximum density.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools

Job Mix Formula; G, RO.

Proposed hot-mix asphalt JMF.

Mixture Proportions; G, RO.

The report of the Contractor's concrete mixture proportioning studies showing the proportions of all ingredients and supporting information on aggregate and other materials that will be used in the manufacture of concrete, at least 14 days prior to commencing concrete placing operations.

SD-06 Test Reports

Initial Tests; G, RO.

Certified copies of test results for approval not less than 20 days before material is required for the work.

Contractor Quality Control; G, RO.

The Contractor shall submit all QC test results to the Contracting Officer on a daily basis as the tests are performed.

Acceptability of Work; G, RO.

The Contractor shall submit all test results to the Contracting Officer on a daily basis as the tests are performed.

SD-07 Certificates

Asphalt Cement Binder; G, RO.

Copies of certified test data.

Bituminous Tack and Prime Coat; G, RO.

Copies of certified test data.

Testing Laboratory; G, RO.

Certification of compliance.

Plant Scale Calibration Certification.

SD-08 Manufacturer's Instructions

Manufacturer's Recommendations; G, RO

Where installation procedures, or any part thereof, are required to be in accordance with the manufacturer's recommendations, printed copies of these recommendations, 20 days prior to use on the project. Installation of the material will not be allowed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

1.7 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by a testing laboratory approved in accordance with Section 01 45 00 QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. The materials shall be tested to establish compliance with the specified requirements; testing shall be performed at the specified frequency. The Contracting Officer may specify the time and location of the tests.

1.8 APPROVAL OF MATERIAL

The source of the material for aggregate base course, subbase course, rigid pavement base course, and aggregate surface course shall be selected 30 days prior to the time the material will be required in the work. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, and plasticity index tests performed on samples taken from the completed and fully compacted base and subbase course.

1.9 WEATHER LIMITATIONS

1.9.1 Hot-Mix Asphalt Pavement

The hot-mix asphalt pavement shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 1. The temperature requirements may be waived by the Contracting Officer, if requested; however, all other requirements, including compaction, shall be met.

Table 1. Surface Temperature Limitations of Underlying Course

Mat Thickness, inches	Degrees F
3 or greater	40
Less than 3	45

Table 1. Surface Temperature Limitations of Underlying Course

Mat Thickness, inches	Degrees F

1.9.2 Bituminous Prime and Tack Coat

Bituminous coat shall be applied only when the surface to receive the bituminous coat is dry. Bituminous coat shall be applied only when the atmospheric temperature in the shade is 50 degrees F or above and when the temperature has not been below 35 degrees F for the 12 hours prior to application.

1.9.3 Portland Cement Concrete Pavement

Limitations on the placing of concrete shall conform to Section 412.09, "Limitations of Placing Concrete" of the CDOT.

1.9.4 Base Course, Subbase Course, Aggregate Surface Course

Construction of aggregate base course, subbase course, rigid pavement base course, and aggregate surface course shall be done when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, the Contractor shall protect all completed areas by approved methods against detrimental effects of freezing. Completed areas damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements.

1.10 PLANT, EQUIPMENT, AND TOOLS

All plant, equipment, and tools used in the performance of the work shall be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing pavements meeting the requirements as set forth herein.

PART 2 PRODUCTS

2.1 Asphalt Cement Binder

Asphalt cement shall conform to the requirements specified in Section 702, "Bituminous Materials" of the CDOT. Asphalt cement binder shall be Performance Grade (PG) 64-22. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting Officer. The supplier is defined as the last source of any modification to the binder.

2.2 HOT-MIX ASPHALT PAVEMENT

Bituminous wearing course shall conform to the requirements specified in either CDOT Section 401, "PLANT MIX PAVEMENTS- GENERAL, and Section 403, "HOT BITUMINOUS PAVEMENT", except as modified herein. The aggregate shall be CDOT Grading SX. Coarse aggregate shall meet the following additional requirements: Percentage of loss shall not exceed 12 after 5 cycles when performed in accordance with AASHTO T 104, using sodium sulfate. The asphalt mix shall be dense-graded and composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The hot-mix asphalt shall be designed using the CDOT Superpave method and the criteria shown in Table 2. If the Tensile Strength Ratio (TSR) of the composite

mixture, as determined by ASTM D 4867/D 4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost. The hot-mix asphalt pavement shall not contain more than 20 percent reclaimed asphalt pavement.

2.2.1 JMF Requirements

The job mix formula (JMF) shall be submitted in writing by the Contractor for approval at least 14 days prior to the anticipated paving start date.

2.2.1.1 CDOT Superpave Mix Design

The Superpave mix design shall meet the requirements in Table 2.

Table 2. Superpave Design Criteria

Test Property			
N(initial)	6		
N(design)	50		
Stability	28 min.		
Air voids, percent	3.5 to 4.5 (4.0 target)		
TSR, minimum percent	75		
Dry Split Tensile Strength	30 psi min.		
Percent Voids in mineral aggregate VMA,	***Design Air Voids***		
	3.5%	4.0%	4.5%
3/4" Nominal Maximum Size*	13.6	13.7	13.8
1/2" Nominal Maximum Size*	14.6	14.7	14.8
Voids Filled with Asphalt (VFA), percent	65 to 80		

* The Nominal Maximum Size is defined as one sieve larger than the first sieve to retain more the 10 percent.
** Interpolate specified VMA values for design air voids between those listed.
*** Extrapolate specified VMA values for production air voids beyond those listed.

The JMF shall include the following as a minimum:

For each aggregate stockpile:

a. Aggregate Sources.

b. Gradation.

c. Atterberg limits.

d. Apparent Specific Gravity, Bulk Specific Gravity.

e. Micro-Deval according to CP-L 4211.

f. Recycled asphalt pavement (RAP).
(1) Percent asphalt
(2) Aggregate Gradation
(3) Effective Specific Gravity (in lieu of the RAP aggregate specific gravity)

Combined Aggregate Properties:

a. Percentage of each aggregate used.

b. Combined Aggregate Gradation, both before and after RAP use.

c. Sand Equivalent.

d. Fine Aggregate Bulk Specific Gravity,
Coarse Aggregate Bulk Specific Gravity.

e. Fine Aggregate Angularity.

f. Combined Aggregate Bulk Specific Gravity.

g. Fractured Faces.

h. Los Angeles Abrasion.

i. Micro-Deval according to CP-L 4211.

j. Effective Specific Gravity.

Source and grade of asphalt cement from CDOT Certified Binder Supplier. Use the actual specific gravity of the asphalt cement in calculations.

Name and percentage of each additive.

For each asphalt content tested:

a. Voids in Mineral Aggregate (VMA) @ N(initial) and N(design).

b. Dust to Asphalt ratio.

c. Percent Voids Filled with Asphalt (VFA) @ N(design).

d. Hveem Stability @ N(design).

e. Maximum Theoretical Specific Gravity.

f. Bulk specific gravity @ N(initial) and N(design).

g. Air voids, Voids in Total Mix (VTM) @ N(initial) and N(design).

Graphs of stability and air voids vs. asphalt content and VMA-VFA, Voids Filled with Asphalt vs. Asphalt content.

Lottman and wet/dry tensile strength at optimum asphalt content.

A 0.45 power plot of the proposed combined aggregate gradation, with

maximum density line, restricted zone and control points included.

2.2.2 Asphalt Cement Binder

Asphalt cement shall conform to the requirements specified in Section 702, "Bituminous Materials" of the CDOT. Asphalt cement binder shall be Performance Grade (PG) 64-22. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting Officer. The supplier is defined as the last source of any modification to the binder.

2.3 BITUMINOUS TACK AND PRIME COAT

Test data indicating grade certification shall be provided by the supplier. Copies of these certifications shall be submitted to the Contracting Officer.

2.3.1 Bituminous Prime Coat

Bituminous prime coat shall conform to the requirements specified in Section 407, Prime Coat, Tack Coat, and Rejuvenating Agent", and Section 702, "BITUMINOUS MATERIALS", of the CDOT. Bituminous materials shall be liquid asphalt, designation MC-30, or MC-70 at the Contractor's option, except that only MC-30 shall be used on dense graded base courses if MC-70 does not adequately penetrate the base course material. In lieu of cut-back asphalt, the Contractor may use cationic emulsified asphalt, designation CSS-l or CSS-lh.

2.3.2 Bituminous Tack Coat

Bituminous tack coat shall conform to the requirements specified in Section 407, "Prime Coat, Tack Coat, and Rejuvenating Agent" of the CDOT. Bituminous material shall be emulsified asphalt designation SS-1 or SS-1h, or cationic emulsified asphalt designation CSS-1 or CSS-1h.

2.4 PORTLAND CEMENT CONCRETE PAVEMENT

2.4.1 Portland Cement Concrete

Portland cement concrete shall conform to the requirements specified in Section 412, "Portland Cement Concrete Pavement", and Section 601 "Structural Concrete" of the CDOT, except as modified herein. Proportioning and required 28-day field compressive strength of the mix shall conform to the requirements of Class "P" concrete, except as modified herein. Concrete shall have a specified compressive strength, f'c, of 5000 psi at 28 days. The coarse aggregate shall have a maximum nominal size of 1-1/2 inches. The water-cement ratio shall not exceed 0.45. The water-cementitious material ratio is based on absolute volume equivalency, where the ratio is determined using the weight of cement for a cement only mix, or using the total volume of cement plus pozzolan converted to an equivalent weight of cement by the absolute volume equivalency method described in ACI 211.1. The concrete shall be air-entrained with a total air content of 6 plus or minus 1.0 percent. The maximum allowable slump of the concrete shall be 3 inches for pavement constructed with fixed forms. For slipformed pavement, the maximum allowable slump shall be 1-1/4 inches.

2.4.1.1 Concrete Composition

Concrete shall be composed of portland cement, fly ash, water, fine and coarse aggregates, and admixtures. Admixtures shall consist of air entraining admixture and may also include water-reducing admixture. High range water-reducing admixtures and admixtures to produce flowable concrete shall not be used. No substitutions shall be made in the materials used in the mixture proportions without additional tests to show that the quality of the concrete is satisfactory.

2.4.1.2 Concrete Mixture Proportioning Studies

Trial design batches, mixture proportioning studies, and testing shall be the responsibility of the Contractor, and shall be performed by the Test Laboratory and signed by a Registered Engineer. The Contractor shall submit the design mixture proportions, laboratory trial mix, aggregate data, and compressive strength test results. No concrete pavement shall be placed until the Contracting Officer has approved the Contractor's mixture proportions. All materials used in mixture proportioning studies shall be representative of those proposed for use on the project. If there is a change in materials, additional mixture design studies shall be made using the new materials. Trial mixtures having proportions, slumps, and air content suitable for the work shall be based on methodology described in ACI 211.1. At least three different water-cementitious ratios, which will produce a range of strength encompassing that required on the project, shall be used. Laboratory trial mixtures shall be proportioned for maximum permitted slump and air content. Maximum sand content shall be 40 percent of the total aggregate SSD weight. Aggregate quantities shall be based on the mass in a saturated surface dry condition.

2.4.1.3 Mixture Proportioning Procedure

The Contractor shall perform the following:

a. Fabricate, cure and test 6 test cylinders per age for each mixture at 7 and 28 days.

b. Using the average strength for each w/(c+p), plot the results from each of the three mixtures on separate graphs for w/(c+p) versus 28-day strength.

c. From the graphs select a w/(c+p) which will produce a mixture giving a 28-day strength equal to the required strength determined in accordance with the following paragraph.

2.4.1.4 Average Strength Required for Mixtures

In order to ensure meeting, during production, the strength requirements specified, the mixture proportions selected shall produce a required average strength, f'cr, exceeding the specified strength, f'c, in accordance with procedures in Chapter 3 of ACI 301, "Proportioning."

2.4.2 Alkali-Silica Reactivity

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate reactivity in accordance with ASTM C 1260. Test both coarse aggregate size groups if from different sources. Evaluate the fine and coarse aggregates separately and in combination, which matches the Contractor's proposed mix design proportioning. Test results of the

combination must have a measured expansion equal to or less than 0.08 percent at 16 days after casting. Should the test data indicate an expansion of greater than 0.08 percent, reject the aggregate(s) or perform additional testing

2.4.3 Welded Steel Wire Fabric

Welded steel wire fabric shall conform to ASTM A 185/A 185M.

2.4.4 Dowels Bars and Tie Bars

Dowel bars and tie bars shall conform to Section 709.03 "Dowel Bars and Tie Bars" of the CDOT.

2.4.5 Epoxy Resin

Epoxy resin materials for embedding dowels shall be two-component materials conforming to the requirements of ASTM C 881/C 881M, Type IV, Grade 3. Class shall be appropriate for each application temperature to be encountered.

2.5 CONCRETE SIDEWALK AND CURB AND GUTTER

2.5.1 General

Portland cement concrete shall conform to Section 601, "STRUCTURAL CONCRETE", of the CDOT, except as modified herein. Concrete shall be Class B or D. Coarse aggregate shall meet Number 57 or 67 gradation. The portland cement shall be Type I or II, and meet the optional chemical requirements for low alkali when tested in accordance with ASTM C 150.

2.5.2 Sidewalks

Portland cement concrete sidewalk shall conform to the requirements as specified in Section 608, "SIDEWALKS AND BIKEWAYS" of the CDOT.

2.5.3 Curb and Gutter

Portland cement concrete curb and gutter shall conform to the requirements as specified in Section 609, "CURB AND GUTTER", of the CDOT.

2.6 CURING MATERIALS

Curing materials for portland cement concrete pavement and sidewalk shall conform to Section 711.01 "Curing Materials" of the CDOT. Liquid membrane-forming compound shall be white pigmented type 2.

2.7 JOINT FILLER, BACKER ROD AND SEALANT

Preformed expansion joint filler and backer rod shall conform to Section 705.01, "Joint Fillers" of the CDOT. Cold-applied silicone joint sealant shall conform to ASTM D 5893. Cold-applied silicone sealant for sidewalks shall be gray or stone in color. Hot-applied joint sealant shall conform to ASTM D 3405 and COE CRD-C 525.

2.8 AGGREGATE BASE COURSE (ABC)

Aggregate base course aggregate shall conform to the requirements specified in Section 304, "AGGREGATE BASE COURSE" and Section 703.03

"AGGREGATE FOR BASES", of the CDOT, except as modified herein. Aggregate base course shall be CDOT Class 4 or 5. In the portion on each sieve specified, the crushed aggregates shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces determined in accordance with ASTM D 5821. When two fractures are contiguous, the angle between planes of the fractures must be at least 30 degrees in order to cound as two fractured faces. Crushed gravel shall be manufactured from gravel particles 50 percent of which, by weight, are retained on the maximum sieve size.

2.9 RIGID PAVEMENT BASE COURSE

Rigid pavement base course aggregate shall conform to the requirements specified in Section 304, "AGGREGATE BASE COURSE" and Section 703.03 "AGGREGATE FOR BASES", of the CDOT, except as modified herein. Rigid pavement base course shall be CDOT Class 5.

2.10 SUBBASE COURSE

Subbase course aggregate shall conform to the requirements specified in Section 304, "AGGREGATE BASE COURSE" and Section 703.03 "AGGREGATE FOR BASES", of the CDOT, except as modified herein. Subbase courses shall be CDOT Class 5.

2.11 AGGREGATE SURFACE COURSE

Crushed aggregate surface course aggregate shall conform to the requirements specified in Section 304, "AGGREGATE BASE COURSE" and Section 703.03 "AGGREGATE FOR BASES", of the CDOT, except as modified herein. Aggregates shall consist of crushed stone or slag, crushed or natural gravel, sand, or other sound, durable materials processed and blended or naturally combined. The aggregate shall meet the gradation requirement for Class 5 except as otherwise specified herein. When tested for gradation, the percentage passing the No. 200 sieve shall be between 8 percent and 15 percent. The amount of flat and elongated particles shall not exceed 20 percent. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. The aggregate for the surface course shall contain a minimum 80 percent crushed material. The portion of the material passing the No. 40 sieve shall have a liquid limit not greater than 35 and a plasticity index of 4 to 9.

2.12 INITIAL TESTS

One of each of the following tests shall be performed on the proposed aggregate base course, rigid pavement base course, subbase course and aggregate surface course material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

a. Sieve Analysis.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

PART 3 EXECUTION

3.1 PAVEMENT REMOVAL

Where p.c. concrete and bituminous pavement is to be removed at the locations shown on the drawings, the pavement shall be sawed with a pre-approved concrete saw so as to leave a straight true edge. P.C. concrete pavement removal shall be accomplished by a full depth double sawcut. The initial sawcut shall be located in the pavement area to be removed and shall be 18 inches from the final sawcut. The pavement material shall be removed in a manner that will not damage the adjacent in-place pavement to remain and as shown on the drawings. The Contractor must demonstrate that his method of removal will not damage adjacent concrete pavement slabs. Any slab found by the Contracting Officer to be damaged by the Contractor's removal methods shall be fully removed and replaced at no cost to the Government. Pavement material from the removal area shall be disposed of outside the limits of Government controlled land at the Contractor's expense .

3.2 HOT-MIX ASPHALT PAVEMENT

Hot-mix asphalt pavement wearing course shall be constructed to the requirements specified in the CDOT, Section 401, "PLANT MIX PAVEMENTS-GENERAL" and Section 403, "HOT BITUMINOUS PAVEMENT", except as modified herein.

3.2.1 Compaction of Mixture

After placing, the mixture shall be thoroughly and uniformly compacted by rolling. The pavement shall be compacted to a density of 92 to 96 percent of the maximum theoretical density, determined according to CP 51. Longitudinal joints shall be compacted to a target density of 92 percent of the maximum specific gravity with a tolerance of plus or minus 4 percent.

3.2.2 Testing Laboratory

The laboratory used to develop the JMF shall meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The certification shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

3.2.3 Contractor Quality Control

3.2.3.1 General Quality Control Requirements

The Contractor shall develop an approved Quality Control Plan. Hot-mix asphalt for payment shall not be produced until the quality control plan

has been approved. The plan shall address all elements which affect the quality of the pavement including, but not limited to:

a. Mix Design

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management

e. Proportioning

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction

l. Surface Smoothness

3.2.3.2 Quality Control Testing

The Contractor shall perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

3.2.3.3 Temperatures

Temperatures shall be checked at least four times during production, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.2.3.4 Aggregate Moisture

The moisture content of aggregate used for production shall be determined at least once during production in accordance with ASTM C 566.

3.2.3.5 Moisture Content of Mixture

The moisture content of the mixture shall be determined at least once during production in accordance with ASTM D 1461 or an approved alternate procedure.

3.2.4 Acceptability of Work

Testing for acceptability of work will be performed by an independent laboratory hired by the Contractor. Test results shall be forwarded daily to the Contracting Officer. The location or time of sampling will be based on the stratified random procedure as described in CP 75.

3.2.4.1 Asphalt Content

At least one asphalt content test shall be taken during production. Asphalt content shall be determined using one of the following methods: the extraction method in accordance with ASTM D 2172, Method A or B, the ignition method in accordance with ASTM D 6307, or the nuclear method in accordance with ASTM D 4125. Calibrate the ignition oven or the nuclear gauge for the specific mix being used. For the extraction method, the weight of ash, as described in ASTM D 2172, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture.

3.2.4.2 Aggregate Gradation

At least one aggregate gradation test shall be taken during production. Aggregate gradation shall be determined from mechanical analysis of recovered aggregate in accordance with ASTM D 5444. When asphalt content is determined by the ignition oven or nuclear method, aggregate gradation shall be determined from hot bin samples on batch plants, or from the cold feed on drum mix plants. For batch plants, aggregates shall be tested in accordance with ASTM C 136 using actual batch weights to determine the combined aggregate gradation of the mixture.

3.2.4.3 Mat Density

At least two mat density tests shall be taken. Density determinations shall be made in accordance with CP 44 using 6-inch diameter cored specimens.

3.2.4.4 Joint Density

One longitudinal joint density test shall be taken for each 1000 LF of joint or fraction thereof. One 6-inch diameter core at a random location within each longitudinal joint sampling section for determination of the joint density. The Contractor shall mark and drill at the location directed by the Contracting Officer and in the presence of the Contracting Officer. Coring locations shall be centered on the visible line where the joint between the two adjacent lifts abut at the surface. The center of all joint cores shall be within plus or minus 1 inch of this visible joint line. Core holes shall be repaired by the Contractor using materials and methods approved by the Contracting Officer. Joint coring shall be conducted within five calendar days of joint construction. Longitudinal joint coring applies to all pavement lifts. When constructing joints in an echelon paving process, the joints shall be clearly marked to ensure consistent coring location. Density determinations shall be made in accordance with CP 44.

3.2.4.5 Laboratory Air Voids and VMA

Mixture samples shall be taken at least once per day and compacted into specimens as described in CP-L 5115. After compaction, the laboratory air voids of each specimen shall be determined in accordance with CP-L 5115 and the VMA of each specimen shall be determined in accordance with CP 48.

3.2.4.6 Surface Smoothness

After the final rolling, but not later than 24 hours after placement, the

surface of the pavement shall be tested by the Contractor using a straightedge to reveal all surface irregularities. The finished surfaces of the pavements shall have no abrupt change of 1/4 inch or more, and all pavements shall be within 1/4 inch in both the longitudinal and transverse directions when tested with an approved 10 foot straightedge. All testing shall be performed in the presence of the Contracting Officer. Detailed notes of the results of the testing shall be kept and a copy furnished to the Government. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines. The straightedge shall be held in contact with the surface and moved ahead the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), the surface shall be finished to meet the approval of the Contracting Officer. If any pavement areas are ground, these areas shall be retested immediately after grinding.

3.3 BITUMINOUS TACK AND PRIME COAT

Except as otherwise specified herein, application of bituminous tack and prime coat shall be in accordance with Section 407, PRIME COAT, TACK COAT, AND REJUVENATING AGENT" of the CDOT. Following application of the bituminous material and prior to the application of the pavement, the bituminous coat shall be allowed to cure and to obtain evaporation of any volatiles or moisture.

3.3.1 Bituminous Tack Coat

Contact surfaces of previously constructed pavement, curbs, manholes, and other structures shall be sprayed with a thin coat of bituminous tack coat. Rate of application shall be not less than 0.05 gallon nor more than 0.15 gallon per square yard.

3.3.2 Bituminous Prime Coat

A prime coat will be required if it will be at least seven days before the hot-mix asphalt layer is constructed on the underlying compacted base course material. The type of liquid asphalt and application rate will be as specified herein. The Contractor shall protect the underlying from any damage (water, traffic, etc.) until the surfacing is placed. If the Contractor places the surfacing within seven days, the choice of protection measures or actions to be taken is at the Contractor's option. Damage to the underlying material caused by lack of, or inadequate, protection shall be repaired (recompacted or replaced) by approved methods at no additional cost to the Government. If the Contractor options to use the prime coat, it shall be applied as soon as possible after consolidation of the underlying material. Rate of application shall be not less than 0.15 gallon nor more than 0.40 gallon per square yard. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper. Immediately after application, the building paper shall be removed and destroyed. Prime coat shall be allowed to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course.

3.4 PORTLAND CEMENT CONCRETE PAVEMENT

Except as otherwise specified herein, portland cement concrete shall be constructed in accordance with the requirements specified in Section 412, "PORTLAND CEMENT CONCRETE PAVEMENT", and Section 601, "STRUCTURAL CONCRETE" of the CDOT. Tining and stationing of concrete is not required.

3.4.1 Batching and Mixing

The batching plant shall conform to NRMCA CPMB 100, the equipment requirements in ASTM C 94/C 94M, and as specified. All concrete materials batching shall meet ASTM C 94/C 94M requirements. Either stationary mixers or truck mixers may be used for mixing concrete if fixed form paving is used. Only stationary mixers may be used for mixing concrete if slipform paving is used. Batching, mixers, mixing time, permitted reduction of mixing time, and concrete uniformity shall meet the requirements of ASTM C 94/C 94M, and shall be documented in the initial weekly QC Report.

3.4.2 Concrete Production

Every load of concrete delivered to the paving site shall be accompanied by a batch ticket from the operator of the batching plant. Tickets shall show at least the mass, or volume, of all ingredients in each batch delivered, the water meter and revolution meter reading on truck mixers and the time of day. Tickets shall be delivered to the placing foreman who shall keep them on file and deliver them to the Government daily.

3.4.3 Spreading

Spreading shall be by machine or hand method. Hand spreading will be permitted only when approved for odd widths or shapes of slabs, or for placement of separate, isolated slabs during removal and replacement type repair operations, or for lanes 50 feet or less in length. Hand spreading, where permitted, shall be done with shovels; rakes shall not be used. Where the concrete is delivered to the form in truck mixers, suitable chutes may be used, provided windrows cover essentially the entire area within the form. In no case shall dumping of concrete in piles be permitted.

3.4.4 Placing Reinforcing Steel

Reinforcement shall be positioned on suitable chairs securely fastened to the subgrade prior to concrete placement, or may be placed on an initial layer of consolidated concrete, with the subsequent layer placed within 30 minutes of the first layer placement.

3.4.5 Joints

Transverse and longitudinal contraction joints shall be of the weakened plane type and shall be formed by sawing. Joints shall be sealed with hot-applied or cold-applied sealant immediately following curing of the concrete or as soon thereafter as weather conditions permit. Before sealing operations commence, a copy of the Manufacturer's Recommendations pertaining to the storage, heating and application of the sealant shall be submitted to the Contracting Officer's representative.

3.4.6 Contractor Quality Control

The Contractor shall perform the inspection and tests described below at the placement and, based upon the results of these inspections and tests, shall take the action required and submit reports as specified. When, in the opinion of the Contracting Officer, the paving operation is out of control, concrete placement shall cease. The Contractor shall furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory.

3.4.6.1 Air Content Testing

Air content tests shall be made when test specimens are fabricated. In addition, at least two other tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of paving. All air content measurements shall be determined in accordance with ASTM C 231. Whenever air content reaches specified limits, an immediate confirmatory test shall be made. If the second test also shows air content at or exceeding specified limits, an adjustment shall immediately be made in the amount of air-entraining admixture batched to bring air content within specified limits. If the next adjusted batch of concrete is not within specified limits, concrete placement shall be halted until concrete air content is within specified limits.

3.4.6.2 Slump Testing

Slump tests shall be made when test specimens are fabricated. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. All slump tests shall be made in accordance with ASTM C 143/C 143M. Whenever slump approaches the maximum limit, an adjustment shall immediately be made in the batch masses of water and fine aggregate, without exceeding the maximum w/(c+p). When a slump result exceeds the specification limit, no further concrete shall be delivered to the paving site until adjustments have been made and slump is again within the limit.

3.4.6.3 Temperature

The temperature of the concrete shall be measured when strength specimens are fabricated.

3.4.6.4 Concrete Strength Testing

Cylinders shall be fabricated, cured and tested for 28-day compressive strength as specified in paragraph: Acceptability of Work. In addition, two cylinders from the same sample of concrete shall be made and tested at 7-day strength. All test cylinders shall be 6 by 12 inch cylinders and shall be fabricated in accordance with ASTM C 192/C 192M, using only steel molds, cured in accordance with ASTM C 31/C 31M, and tested in accordance with ASTM C 39/C 39M.

3.4.6.5 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily.

3.4.7 Acceptability of Work

The pavement will be accepted on the basis of tests made by the Contractor or its suppliers, as specified herein. The Government may, at its discretion, make check tests to validate the results of the Contractor's testing. A standard lot for all requirements will be equal to the entire production for the project. In order to evaluate surface smoothness, each lot will be divided into four equal sublots. One composite sample of concrete from each sublot shall be obtained at the placement in accordance with ASTM C 172 from one batch or truckload. Concrete samples shall be taken by the Contractor to determine the slump, air content, and strength of the concrete. Test cylinders shall be made for determining conformance with the strength requirements of these specifications and, when required, for determining the time at which pavements may be placed into service. The Contractor shall furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory.

3.4.7.1 Evaluation Sampling

Sampling, testing, and mixture proportioning shall be performed by a commercial Testing Laboratory, conforming with ASTM C 1077. The individuals who sample and test concrete and concrete constituents shall be certified as American Concrete Institute (ACI) Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete shall be certified as ACI Concrete Construction Inspector, Level II. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. All mix design, weekly quality control reports, smoothness reports, and project certification reports shall be signed by a Registered Engineer.

3.4.7.2 Strength Requirements

A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. The strength of the concrete will be considered satisfactory so long as the average of all sets of test results equals or exceeds the specified 28-day field compressive strength and no individual test result falls below the specified strength by more than 500 psi. Lots which are unsatisfactory and do not meet the strength requirements shall be removed and replaced by the Contractor at no additional cost to the Government.

3.4.7.3 Surface Smoothness Requirements

The surface of the pavement in each sublot shall be tested by the Contractor with a 10-foot straightedge to identify all surface irregularities exceeding the tolerances specified below. All testing shall be performed in the presence of the Contracting Officer. The pavement shall be tested in both a longitudinal and a transverse direction on parallel lines approximately 15 feet apart. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface, in the area between these two high points. The finished surfaces of the pavements shall have no abrupt change of 1/8 inch or more. All pavements shall have a surface smoothness

tolerance within 1/4 inch in the transverse and longitudinal direction, except that roads and streets shall have tolerance of 3/16 inchin the longitudinal direction. In areas not meeting the specified limits for surface smoothness, high areas may be reduced by grinding to attain the required smoothness, except as depth is limited below. Grinding the hardened concrete with a surface grinding machine shall not occur unless the concrete is at least 14 days old. The depth of grinding shall not exceed 1/4 inch. All areas in which grinding has been performed will be subject to the thickness tolerances specified in paragraph: Thickness Determination. Any grinding performed on individual slabs with excessive deficiencies shall be performed at the Contractor's own decision without entitlement to additional compensation if eventual removal of the slab is required. Pavement areas reduced by grinding shall be retested immediately after grinding. When more than 10.0 percent of all measurements in sublot exceed the tolerances above after any reduction of high spots, the sublot shall be removed and replaced by the Contractor at no additional cost to the Government. The measurements shall be properly referenced in accordance with paving lane identification and stationing, and a report given to the Government within 24 hours after measurement is made. A final report of surface testing, containing all surface measurements and a description of all actions taken to correct deficiencies, shall be provided to the Government upon conclusion of surface testing.

3.4.7.4 Thickness Determination

The thickness of the pavement shall be determined by the Government on the basis of measurements made on 4 inch diameter cores which shall be drilled by the Contractor, within 7 days after placement of the concrete. Cores shall be drilled at the points directed by the Contracting Officer and there shall be at least two cores taken per lot. The Contractor shall fill the core holes with concrete containing an expanding admixture, as directed. The cores shall be evaluated for thickness of the pavement in accordance with ASTM C 174/C 174M. For pavements less than 8 inches in thickness, when any core shows a deficiency in thickness greater than 1/4 inch, the pavement area represented by the core shall be removed and replaced by the Contractor at no cost to the Government. For pavements greater than 8 inches in thickness, when any core shows a deficiency in thickness greater than 1/2 inch, the pavement area represented by the core shall be removed and replaced by the Contractor at no cost to the Government.

3.5 CONCRETE SIDEWALK AND CURB AND GUTTER

The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.5.1 Sidewalks

Except as otherwise specified herein, portland cement concrete sidewalk shall be constructed in accordance with Section 608, "SIDEWALKS AND BIKEWAYS" of the CDOT. Subgrade shall be placed and compacted in conformance with Section 31 00 00 EARTHWORK. The subgrade shall be tested for grade and cross section by means of a template extending the full width of the sidewalk and supported between side forms. Finished surfaces

shall not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch. All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Sidewalk joints shall be constructed to divide the surface into square or rectangular areas. Spacing of transverse and longitudinal contraction and expansion joints shall be as indicated. At the end of the curing period, expansion joints shall be carefully cleaned and filled with cold-applied joint sealant (gray or stone color) as indicated on the drawings. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and the atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material.

3.5.2 Curb and Gutter

Except as otherwise specified herein, portland cement concrete curb and gutter shall be constructed in accordance with Section 609, "CURB AND GUTTER", of the CDOT. The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule". Approved slipformed curb and gutter machines may be used in lieu of hand placement. Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius as shown on the drawings. Finished surfaces shall not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch. Contraction joints shall be spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length. Contraction joints shall be constructed by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing. Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints at least 1/2 inch in width shall be provided at intervals not exceeding 40 feet. Expansion joints and the top 1 inch depth of contraction joints shall be sealed with cold or hot-applied sealant immediately following curing of the concrete or as soon thereafter as weather permits. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and the atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.5.3 Curing and Protection

Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Concrete shall be cured using one of the following methods

3.5.3.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 6 inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.5.3.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18 inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.5.3.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as specified in Section 412.14, "Curing" of the CDOT.

3.6 AGGREGATE COURSES

Aggregate base course, subbase course, rigid pavement base course, and aggregate surface course shall conform to, and be constructed in accordance with, the requirements specified in Section 304, "AGGREGATE BASE COURSE" and Section 703.03, "AGGREGATE FOR BASES" of the CDOT, except as modified herein. The aggregate base course, subbase course, rigid pavement base course, and aggregate surface course shall be compacted to 100 percent of laboratory maximum density.

3.6.1 Acceptability of Work

The aggregate base course, subbase course, rigid pavement base course, and aggregate surface course will be accepted on the basis of tests made by the Contractor as specified herein. The Government may, at its discretion, make check tests to validate the results of the Contractor's testing.

3.6.1.1 In-Place Tests

One of each of the following tests shall be performed on samples taken from the placed and compacted aggregate course. Samples shall be taken and tested at the rates indicated for each layer of material placed.

a. Density tests shall be performed on every lift of material placed and at a frequency of one set of tests for every 250 square yards, or portion thereof, of completed area.

b. Sieve Analysis including 0.02 mm inch size material shall be performed on every lift of material placed and at a frequency of one test for every 1000 square yards, or portion thereof, of completed area for every 500 tons, or portion thereof, of material placed.

c. Liquid limit and plasticity index tests shall be performed at the same frequency as the sieve analysis.

3.6.1.2 Thickness

The total compacted thickness of the aggregate course shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. The total thickness of the aggregate course shall be measured at intervals in such a manner as to ensure one measurement for each 500 square yards of aggregate course. Measurements shall be made in 3 inch diameter test holes penetrating the aggregate course.

3.6.1.3 Smoothness

The surface of the top layer shall show no deviations in excess of 3/8 inch when tested with a 10-foot straightedge applied parallel with and at right angles to the centerline of the area to be paved. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 50 foot intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

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SECTION 32 11 20

BASE COURSE FOR RIGID AND SUBBASES FOR FLEXIBLE PAVING
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 88	(2013) Standard Method of Test for Particle Size Analysis of Soils

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2017a) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4718/D4718M	(2015) Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM E11	(2022) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.2 DEGREE OF COMPACTION

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the laboratory maximum dry density in accordance with ASTM D1557 Method C and corrected with ASTM D4718/D4718M.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools; G, RO

SD-06 Test Reports

Initial Tests; G, RO

In-Place Tests; G, RO

1.4 QUALITY ASSURANCE

Sampling and testing are the responsibility of the Contractor. Perform sampling and testing using a laboratory approved in accordance with Section 01 45 00QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified requirements and perform testing at the specified frequency. The Contracting Officer may specify the time and location of the tests. Furnish copies of test results to the Contracting Officer within 24 hours of completion of the

tests.

1.4.1 Sampling

Take samples for laboratory testing in conformance with ASTM D75/D75M.

1.4.2 Tests

1.4.2.1 Gradation

Perform gradation in conformance with ASTM C117 and ASTM C136/C136M using sieves conforming to ASTM E11.

1.4.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D4318.

1.4.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture in accordance with paragraph DEGREE OF COMPACTION.

1.4.2.4 Field Density Tests

Measure field density in accordance with ASTM D1556/D1556M, or ASTM D6938. For the method presented in ASTM D1556/D1556M, use the base plate, as shown in the drawing. For the method presented in ASTM D6938, check the calibration curves and adjust them, if necessary, using only the sand cone method as described in Annex A2, of the ASTM publication. Use ASTM D6938 to determine the moisture content of the soil. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. Make the calibration checks of both the density and moisture gauges using the prepared containers of material method, as described in Annex A2, in ASTM D6938, on each different type of material to be tested at the beginning of a job and at intervals as directed. Submit calibration curves and related test results prior to using the device or equipment being calibrated.

1.4.2.5 Wear Test

Perform wear tests on subbase course andrigid pavement base course material in conformance with ASTM C131/C131M.

1.4.2.6 Weight of Slag

Determine weight per cubic foot of slag in accordance with ASTM C29/C29M.

1.5 ENVIRONMENTAL REQUIREMENTS

Perform construction when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Subbase Course

Provide aggregates consisting of crushed stone or slag, gravel, shell, sand, or other sound, durable, approved materials processed and blended or naturally combined. Provide aggregates which are free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. The percentage of loss of material retained on the No. 4 sieve must not exceed 50 percent after 500 revolutions when tested in accordance with ASTM C131/C131M. Provide aggregate that is reasonably uniform in density and quality. Provide slag that is an air-cooled, blast-furnace product having a dry weight of not less than 65 pcf. Provide aggregates with a maximum size of 2 inch and within the limits specified as follows:

Maximum Allowable Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	No. 1
No. 10	50
No. 200	8

Particles having diameters less than 0.02 mm must not be in excess of 3 percent by weight of the total sample tested as determined in accordance with AASHTO T 88. The portion of any blended component and of the completed course passing the No. 40 sieve must be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.1.2 Rigid Pavement Base Course

Provide aggregates consisting of crushed stone or slag, gravel, shell, sand, or other sound, durable, approved materials processed and blended or naturally combined. Provide aggregates which are durable and sound, free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material. The percentage of loss of material retained on the No. 4 sieve must not exceed 50 percent after 500 revolutions when tested in accordance with ASTM C131/C131M. At least 50 percent by weight retained on each sieve must have one freshly fractured face with the area at least equal to 75 percent of the smallest midsectional area of the piece. Provide aggregate that is reasonably uniform in density and quality. Provide slag that is an air-cooled, blast-furnace product having a dry weight of not less than 65 pcf. Provide aggregates having a maximum size of 2 inches and within the limits specified as follows:

Maximum Allowable Percentage by Weight Passing Square-Mesh Sieve

Sieve Designation	Rigid Pavement Base Course
No. 10	85
No. 200	8

Particles having diameters less than 0.02 mm must not be in excess of 3 percent by weight of the total sample tested as determined in accordance with AASHTO T 88. The portion of any blended component and of the completed course passing the No. 40 sieve must be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 6. The Contractor is responsible for any additional stability required to provide a working platform for construction equipment. If the Contractor can demonstrate with a test section that a material has adequate stability to support construction equipment, the fractured face requirement can be deleted, subject to the approval of the Contracting Officer.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Initial Tests

Perform one of each Initial Tests of the following tests on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements prior to installation. Complete this testing for each source if materials from more than one source are proposed.

a. Sieve Analysis including 0.02 mm size material.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

Submit certified copies of test results for approval not less than 30 days before material is required for the work.

2.2.2 Approval of Material

Tentative approval of material will be based on initial test results.

2.3 EQUIPMENT, TOOLS, AND MACHINES

All plant, equipment, and tools used in the performance of the work are subject to approval by the Government before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Use equipment capable of minimizing segregation, producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Provide adequate drainage during the entire period of construction to prevent water from collecting or standing on the working area.

3.2 OPERATION OF AGGREGATE SOURCES

Condition aggregate sources on private lands in accordance with local laws and authorities. Clearing, stripping and excavating are the responsibility of the Contractor. Operate the aggregate sources to

produce the quantity and quality of materials meeting the specified requirements in the specified time limit.

3.3 STOCKPILING MATERIAL

Clear and level storage sites prior to stockpiling of material. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Stockpile aggregates on the cleared and leveled areas designated to prevent segregation. Stockpile materials obtained from different sources separately.

3.4 PREPARATION OF UNDERLYING COURSE OR SUBGRADE

Clean the underlying course or subgrade of all foreign substances prior to constructing the rigid pavement base course. Do not construct rigid pavement base course on underlying course or subgrade that is frozen. Construct the surface of the underlying course or subgrade to meet specified compaction and surface tolerances. Correct ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the specified requirements set forth herein by loosening and removing soft or unsatisfactory material and adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D2487, stabilize the surface prior to placement of the overlying course. Stabilize by mixing the overlying course material into the underlying course and compacting by approved methods. Consider the stabilized material as part of the underlying course and meet all requirements of the underlying course. Do not allow traffic or other operations to disturb the finished underlying course and maintain in a satisfactory condition until the overlying course is placed.

3.5 GRADE CONTROL

Provide a finished and completed subbase and rigid pavement base courses conforming to the lines, grades, and cross sections shown. Place line and grade stakes as necessary for control.

3.6 MIXING AND PLACING MATERIALS

Mix and place the materials to obtain uniformity of the material at the water content specified. Make such adjustments in mixing or placing procedures or in equipment as directed to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to provide a satisfactory course.

3.7 LAYER THICKNESS

Compact the completed course to the thickness indicated. No individual layer may be thicker than 6 inches nor be thinner than 3 inches in compacted thickness. Compact the course(s) to a total thickness that is within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course will be considered as conforming to the specified thickness requirements. The average job thickness will be the average of all thickness measurements taken for the job and must be within 1/4 inch

of the thickness indicated. Measure the total thickness of the course(s) at intervals of one measurement for each 500 square yards of completed course. Measure total thickness using 3 inch diameter test holes penetrating the completed course.

3.8 COMPACTION

Compact each layer of the material, as specified, with approved compaction equipment. Maintain water content during the compaction procedure to within plus or minus 2 percent of optimum water content determined from laboratory tests as specified in this Section. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Slightly vary the length of alternate trips of the roller. Adjust speed of the roller as needed so that displacement of the aggregate does not occur. Compact mixture with hand-operated power tampers in all places not accessible to the rollers. Continue compaction of the subbase until each layer is compacted through the full depth to at least 100 percent of laboratory maximum density. Make such adjustments in compacting or finishing procedures as may be directed by the Contracting Officer to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory subbase and rigid pavement base course. Remove any materials that are found to be unsatisfactory and replace with satisfactory material or rework, as directed, to meet the requirements of this specification.

3.9 EDGES OF SUBBASE AND RIGID PAVEMENT BASE COURSE

Place approved material along the outer edges of the subbase and rigid pavement base course in sufficient quantity to compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, simultaneously roll and compact at least a 2 foot width of this shoulder material with the rolling and compacting of each layer of the subbase and rigid pavement base course, as directed.

3.10 FINISHING

Finish the surface of the top layer of rigid pavement base course after final compaction by cutting any overbuild to grade and rolling with a steel-wheeled roller. Do not add thin layers of material to the top layer of rigid pavement base course to meet grade. If the elevation of the top layer of rigid pavement base course is 1/2 inch or more below grade, scarify the top layer to a depth of at least 3 inches and blend new material in and compact to bring to grade. Make adjustments to rolling and finishing procedures as directed by the Contracting Officer to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable rigid pavement base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, scarify the unsatisfactory portion and rework and recompact it or replace as directed.

3.11 SMOOTHNESS TEST

Construct the top layer so that the surface shows no deviations in excess of 3/8 inch when tested with a 12 foot straightedge. Take measurements in successive positions parallel to the centerline of the area to be paved. Also take measurements perpendicular to the centerline at 50 foot intervals. Correct deviations exceeding this amount by removing material and replacing with new material, or by reworking existing material and

compacting it to meet these specifications.

3.12 FIELD QUALITY CONTROL

3.12.1 In-Place Tests

Perform one of each of the following tests on samples taken from the placed and compacted subbase and rigid pavement base course. Take samples and test at the rates indicated.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 500 square yards, or portion thereof, of completed area.

b. Perform sieve analysis including 0.02 mm size material on every lift of material placed and at a frequency of one sieve analysis for every 1,000 square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the thickness of each course at intervals providing at least one measurement for each 500 square yards or part thereof. Measure the thickness using test holes, at least 3 inches in diameter through the course.

3.12.2 Approval of Material

Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and fully compacted course(s).

3.13 TRAFFIC

Completed portions of the rigid pavement base course can be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Do not allow heavy equipment on the completed rigid pavement base course except when necessary for construction. When it is necessary for heavy equipment to travel on the completed rigid pavement base course, protect the area against marring or damage to the completed work. Repair damage to meet these specifications.

3.14 MAINTENANCE

Maintain the completed course in a satisfactory condition until the full pavement section is completed and accepted. Immediately repair any defects and repeat repairs as often as necessary to keep the area intact. Retest any course that was not paved over prior to the onset of winter to verify that it still complies with the requirements of this specification. Rework or replace any area that is damaged as necessary to comply with this specification.

3.15 DISPOSAL OF UNSATISFACTORY MATERIALS

Dispose of any unsuitable materials that have been removed outside the limits of Government-controlled land . No additional payments will be made for materials that have to be replaced.

-- End of Section --

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SECTION 32 11 23

AGGREGATE BASE COURSES
05/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C29/C29M	(2017a) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1556/D1556M	(2015; E 2016) Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D3665	(2012; R 2017) Standard Practice for

	Random Sampling of Construction Materials
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4718/D4718M	(2015) Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6938	(2017a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D7928	(2017) Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
ASTM E11	(2022) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Aggregate Base Course

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 Graded-Crushed Aggregate Base Course

Graded-crushed aggregate (GCA) base course is well graded, crushed, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.3 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the laboratory maximum dry density in accordance with ASTM D1557 Method C and corrected with ASTM D4718/D4718M.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Plant, Equipment, and Tools; G, RO

SD-06 Test Reports

Initial Tests; G, RO

In-Place Tests; G, RO

1.4 QUALITY ASSURANCE

Perform sampling and testing using a laboratory approved in accordance with Section 01 45 00 QUALITY CONTROL. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified requirements and perform testing at the specified frequency. The Contracting Officer may specify the time and location of the tests. Furnish copies of test results to the Contracting Officer within 24 hours of completion of the tests.

1.4.1 Sampling

Take samples for laboratory testing in conformance with ASTM D75/D75M.

1.4.2 Tests

1.4.2.1 Gradation Analysis

Perform gradation analysis in conformance with ASTM C117 and ASTM C136/C136M using sieves conforming to ASTM E11.Perform particle-size analysis of the soils in conformance with ASTM D7928.

1.4.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D4318.

1.4.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture content in accordance with paragraph DEGREE OF COMPACTION.

1.4.2.4 Field Density Tests

Measure field density in accordance with ASTM D1556/D1556M, or ASTM D6938. For the method presented in ASTM D1556/D1556M use the base plate as shown in the drawing. For the method presented in ASTM D6938 check the

calibration curves and adjust them, if necessary, using only the sand cone method as described in Annex A2 of ASTM D6938. Use ASTM D6938 to determine the moisture content of the soil. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938. Make the calibration checks of both the density and moisture gauges using the prepared containers of material method, as described in Annex A2 of ASTM D6938, on each different type of material being tested at the beginning of a job and at intervals as directed. Submit calibration curves and related test results prior to using the device or equipment being calibrated.

1.4.2.5 Wear Test

Perform wear tests on ABC course material in conformance with ASTM C131/C131M.

1.4.2.6 Flat and Elongated Pieces

Determine flat and elongated pieces on ABC course material in conformance with ASTM D4791, Method A.

1.4.2.7 Fractured Faces

Perform fractured faces test on ABC coarse aggregate in comformance with ASTM D5821.

1.4.2.8 Weight of Slag

Determine weight per cubic foot of slag in accordance with ASTM C29/C29M on the ABC course material.

1.5 ENVIRONMENTAL REQUIREMENTS

Perform construction when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

1.6 ACCEPTANCE

1.6.1 Tolerances

Acceptance of ABC is based on compliance with the tolerances presented in Table 1. Remove any materials found to be non-compliant and replace with compliant material or rework, as directed, to meet the requirements of this specification

TABLE 1

Measurement	Tolerance
Grade	Plus 1/4 inch, Minus 1/2 inch
Smoothness	Plus/Minus 3/8 inch

TABLE 1	
Individual Test Total Thickness	Plus/Minus
Average Job Thickness	Plus/Minus
Compaction	Minimum 100 percent

PART 2 PRODUCTS

2.1 AGGREGATES

Provide ABC consisting of clean, sound, durable particles of crushed stone, crushed gravel, angular sand, or other approved material. Provide ABC that is free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the No. 4 sieve is known as coarse aggregate; that portion passing the No. 4 sieve is known as fine aggregate. When the coarse and fine aggregate is supplied from more than one source, provide aggregate from each source that meets the specified requirements.

2.1.1 Coarse Aggregate

Provide coarse aggregates with angular particles of uniform density. Separately stockpile coarse aggregate supplied from more than one source.

a. Crushed Gravel: Provide crushed gravel that has been manufactured by crushing gravels and that meets all the requirements specified below.

b. Crushed Stone: Provide crushed stone consisting of freshly mined quarry rock, meeting all the requirements specified below.

2.1.1.1 Aggregate Base Course

Limit the percentage of loss of ABC coarse aggregate to a maximum of 50 percent when tested in accordance with ASTM C131/C131M. Provide aggregate that contains a maximum of 30 percent flat and elongated particles when tested in accordance with ASTM D4791, Method A. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3. In the portion retained on each sieve specified, provide crushed aggregates containing a minimum of 50 percent by weight of crushed pieces having two or more freshly fractured faces determined in accordance with ASTM D5821. When two fractures are contiguous, the angle between planes of the fractures is required to be a minimum of 30 degrees in order to count as two fractured faces. Manufacture crushed gravel from gravel particles 50 percent of which, by weight, are retained on the maximum size sieve listed in TABLE 2.

2.1.2 Fine Aggregate

Provide fine aggregates consisting of angular particles of uniform density.

2.1.2.1 Aggregate Base Course

Provide ABC fine aggregate that consists of screenings, angular sand, crushed recycled concrete fines, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

2.1.3 Gradation Requirements

Apply the specified gradation requirements to the completed base course. Provide aggregates that are continuously well graded within the limits specified in TABLE 2. Use sieves that conform to ASTM E11.

TABLE 2. GRADATION OF AGGREGATES

Percentage By Weight Passsing Square-Mesh Sieve	
Sieve Designation	No.3
2 inch	---
1-1/2 inch	---
1 inch	100
1/2 inch	40-70
No. 4	20-50
No. 10	15-40
No. 40	5-25
No. 200	0-8

NOTE 1: Limit particles having diameters less than 0.02 mm to a maximum of 3 percent by weight of the total sample tested as determined in accordance with ASTM D7928.

NOTE 2: The values are based on aggregates of uniform specific gravity. If materials from different sources are used for the coarse and fine aggregates, test the materials in accordance with ASTM C127 and ASTM C128 to determine their specific gravities. Correct the percentages passing the various sieves as directed if the specific gravities vary by more than 10 percent.

NOTE 3: Gradations containing more than 30 percent retained on the ¾ inch sieve can produce inconsistent compacted density values when tested in accordance with paragraph DEGREE OF COMPACTION.

2.2 LIQUID LIMIT AND PLASTICITY INDEX

Apply liquid limit and plasticity index requirements to the completed

course and to any component that is blended to meet the required gradation. Limit the portion of any component or of the completed course passing the No. 40 sieve to be either nonplastic or have a maximum liquid limit of 25 and a maximum plasticity index of 5.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

2.3.1 Initial Tests

Perform one of each of the following initial tests on the proposed material prior to commencing construction to demonstrate that the proposed material meets all specified requirements when furnished. Complete this testing for each source if materials from more than one source are proposed. Submit certified copies of test results for approval a mimimum of 30days before material is required for the work.

a. Gradation Analysis including 0.02 mm material.

b. Liquid limit and plasticity index.

c. Moisture-density relationship.

d. Wear.

e. Flat and Elongated Pieces.

f. Soundness.

g Fractured Faces.

2.3.2 Approval of Material

Tentative approval of material will be based on initial test results.

2.4 EQUIPMENT, TOOLS, AND MACHINES

All plant, equipment, and tools used in the performance of the work are subject to approval by the Government before the work is started. Maintain all plant, equipment, and tools in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Use equipment capable of minimizing segregation, producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the ABCis constructed in more than one lift, clean the previously constructed lift of loose and foreign matter by sweeping with power sweepers or power brooms. Use hand brooms in areas where power cleaning is not practicable. Provide adequate drainage during the entire period of construction to prevent water from collecting or standing on the working area.

3.2 OPERATION OF AGGREGATE SOURCES

Condition aggregate sources on private lands in accordance with local laws or authorities. Clear, strip, and excavate as required. Condition aggregate sources on Government property to readily drain and leave in a satisfactory condition upon completion of the work.

3.3 STOCKPILING MATERIAL

Clear and level storage sites prior to stockpiling of material. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Stockpile aggregates on the cleared and leveled areas designated to prevent segregation. Stockpile materials obtained from different sources separately.

3.4 PREPARATION OF UNDERLYING COURSE OR SUBGRADE

Clean the underlying course or subgrade of all foreign substances prior to constructing the base course(s). Do not construct base course(s) on underlying course or subgrade that is frozen. Construct the surface of the underlying course or subgrade to meet specified compaction and surface tolerances. Correct ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the specified requirements set forth herein by loosening and removing soft or unsatisfactory material and adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D2487, stabilize the surface prior to placement of the base course(s). Stabilize by mixing ABC into the underlying course and compacting by approved methods. Proof roll in accordance with paragraph PROOF ROLLING. Consider the stabilized material as part of the underlying course and meet all requirements of the underlying course. Do not allow traffic or other operations to disturb the finished underlying course and maintain in a compliant condition until the base course is placed.

3.5 GRADE CONTROL

Provide a finished and completed base course conforming to the lines, grades, and cross sections shown. Place line and grade stakes as necessary for control.

3.6 MIXING AND PLACING MATERIALS

3.6.1 Mixing

Mix the coarse and fine aggregates in a stationary plant. Make adjustments in mixing procedures or in equipment to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to produce a satisfactory base course meeting all requirements of this specification.

3.6.2 Placing

Place the mixed material on the prepared subgrade or subbase in lifts of uniform thickness with an approved spreader. Place the lifts so that when compacted they are true to the grades or levels required with the least possible surface disturbance. Where the base course is placed in more than one lift, clean the previously constructed lift of loose and foreign

matter by sweeping with power sweepers, power brooms, or hand brooms. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to produce an acceptable base course.

3.7 LAYER THICKNESS

Compact the completed base course to the thickness indicated. Limit individual compacted lifts to a maximum thickness of 6 inches and a minimum thickness of 3 inches. Compact the base course(s) to a total thickness that is within the tolerances of paragraph ACCEPTANCE of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course will be considered as conforming to the specified thickness requirements. However, the requirements for wearing course thickness and plan grade are still applicable. The average job thickness will be the average of all thickness measurements taken for the job and within the tolerances of paragraph ACCEPTANCE of the thickness indicated.

3.8 COMPACTION

Compact each lift of the base course, as specified, with approved compaction equipment. For cohesive soils, maintain water content during the compaction procedure to within plus or minus 2 percent of the optimum water content determined from laboratory tests as specified and for cohesionless soils, maintain the water content to facilitate compaction without bulking. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Slightly vary the length of alternate trips of the roller. Adjust speed of the roller as needed so that displacement of the aggregate does not occur. Compact mixture with hand-operated power tampers in all places not accessible to the rollers. Continue compaction until each lift is compacted through the full depth to meet the compaction requirements of Table 1. Make such adjustments in compacting or finishing procedures to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to produce a compliant base course. Remove any materials found to be non-compliant and replace with compliant material or rework, as directed, to meet the requirements of this specification.

3.9 PROOF ROLLING

In addition to the compaction specified,the subgrade under the proposed pavement should also be thoroughly proof-rolled using a heavily loaded vehicle having a single axle weight of at least 18,000 lbs. and a minimum tire pressure of 70 psi.. A coverage is defined as the application of one tire print over the designated area. In the areas designated, apply proof rolling to the top of the underlying material on which the base course is laid and to the top of each lift of the completed base course. Maintain water content of the underlying material and each lift of the base course as specified in Paragraph COMPACTION from start of compaction to completion of proof rolling of that lift. Remove any base course materials or any underlying materials that produce permanent deformation exceeding 3/8 inch by proof rolling and replace with satisfactory materials. Then recompact and proof roll to meet these specifications. The proof roll will be observed and accepted by a representative of the Contracting Officer.

3.10 EDGES OF BASE COURSE

Place the base course(s) so that the completed section is a minimum of 2 feet wider, on all sides, than the next lift that will be placed above it. Place approved material along the outer edges of the base course in sufficient quantity to compact to the thickness of the course being constructed. When the course is being constructed in two or more lifts, simultaneously roll and compact at least a 2 foot width of this shoulder material with the rolling and compacting of each lift of the base course.

3.11 FINISHING

Finish the surface of the top lift of base course after final compaction and proof rolling by cutting any overbuild to grade and rolling with a steel-wheeled roller. Do not add thin lifts of material to the top lift of base course to meet grade. If the elevation of the top lift of base course exceeds the tolerances of paragraph ACCEPTANCE, scarify the top lift to a depth of at least 3 inches and blend new material in and compact and proof roll to bring to grade. Make adjustments to rolling and finishing procedures to minimize segregation and degradation, obtain grades, maintain moisture content, and produce an acceptable base course. If the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, scarify the non-compliant portion and rework and recompact it or replace as directed.

3.12 SMOOTHNESS TEST

Construct the top lift so that the surface shows no deviations exceeding the tolerances of paragraph ACCEPTANCE when tested with a 12 foot straightedge. Test the entire area in both a longitudinal and a transverse direction on parallel lines. Perform the transverse lines at a maximum spacing of 15 feet or less apart, as directed. Perform the longitudinal lines at the centerline of each placement lane, regardless of whether multiple lanes are allowed to be paved at the same time, and at the 1/8th point in from each side of the lane. Hold the straightedge in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and measuring the maximum gap between the straightedge and the pavement surface. Determine measurements along the entire length of the straight edge. Correct deviations exceeding this amount by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.13 FIELD QUALITY CONTROL

3.13.1 In-Place Tests

Perform each of the following in-place tests on samples taken from the placed and compacted ABC. Determine sample locations using random sampling in accordance with ASTM D3665. Take samples and test at the rates indicated.

a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 250 square yards, or portion thereof, of completed area. Gradations containing more than 30 percent retained on the ¾ inch sieve can produce inconsistent compacted density values when tested in accordance with paragraph DEGREE OF

COMPACTION.

b. Perform gradation analysis including 0.02 mm size material on every lift of material placed and at a frequency of one sieve analysis for every 500 square yards, or portion thereof, of material placed.

c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.

d. Measure the thickness of the base course at intervals providing at least one measurement for each 500 square yards of base course or part thereof. Measure the thickness using test holes, at least 3 inch in diameter through the base course.

3.13.2 Approval of Material

Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and fully compacted course(s).

3.14 TRAFFIC

Completed portions of the base course can be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Do not allow heavy equipment on the completed base course except when necessary for construction. When it is necessary for heavy equipment to travel on the completed base course, protect the area against marring or damage to the completed work. Repair damage to meet these specifications.

3.15 MAINTENANCE

Maintain the base course in a satisfactory condition until the full pavement section is completed and accepted. Immediately repair any defects and repeat repairs as often as necessary to keep the area intact. Retest any base course that was not paved over prior to the onset of winter to verify that it still complies with the requirements of this specification. Rework or replace any area of base course that is damaged as necessary to comply with this specification.

3.16 DISPOSAL OF UNSATISFACTORY MATERIALS

Dispose of any unsuitable materials that have been removed outside the limits of Government-controlled land. No additional payments will be made for materials that have to be replaced.

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BITUMINOUS TACK AND PRIME COATS
05/24

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D8	(2022a) Standard Terminology Relatimg to Materials for Roads and Pavements
ASTM D88/D88M	(2007; R 2009; E 2019) Standard Test Method for Saybolt Viscosity
ASTM D140/D140M	(2016) Standard Practice for Sampling Asphalt Materials
ASTM D977	(2020) Standard Specification for Emulsified Asphalt
ASTM D2170/D2170M	(2018) Standard Test Method for Kinematic Viscosity of Asphalts (Bitumens)
ASTM D2397/D2397M	(2020) Standard Specification for Cationic Emulsified Asphalt

1.2 DEFINITIONS

See ASTM D8 for more definitions relating to this specification.

1.2.1 Prime Coat

Application of a low-viscosity asphalt material to an absorptive surface, such as an unbound granular layer, designed to penetrate, bond, temporarily weatherproof, and stabilize this existing surface and to promote adhesion between it and construction course that follows.

1.2.2 Tack Coat

Tack Coat is also referred to as bond coat. Tack coat is an application of bituminous material to an existing relatively nonabsorptive surface, such as existing densely graded asphalt mixture (milled or new), to provide a thorough bond between old and new surfacing.

1.2.3 Emulsion

Emulsion is also known as emulsified asphalt or asphalt emulsion. Mostly made of paving grade asphalt binder and water containing a small amount of emulsifying agent. Emulsifying agent may also be referred to as a surfactant. The purpose of the surfactant is to prevent the coalescence

of the asphalt droplets and to keep them suspended independently in the water. Surfactants used in the emulsions can be produced with positive or negative charges resulting in anionic or cationic emulsions.

1.2.4 Diluted Emulsion

An emulsion that has been diluted by adding an additional amount of water equal to or less than the total volume of emulsion.

1.2.5 Residual Asphalt

The amount of asphalt binder remaining after all water has evaporated from an asphalt emulsion.

1.2.6 Shot Rate

Shot rate, also referred to as bar rate, is the application rate set by the computerized control system in the bituminous distributor for the cutback asphalt, asphalt binder, or the asphalt emulsion. This value is typically represented by units of g/yd^2.

1.2.7 Emulsion Break

Emulsion break, also referred to as break or breaking, is the initiation of asphalt binder droplets coalescing and water separating within the emulsion, at which point color begins to change from brown to black.

1.2.8 Emulsion Set

Emulsion set, also referred to as cure or curing, is the completion of emulsion breaking when water has evaporated, leaving behind a thin film of asphalt binder residue.

1.2.9 Certificate of Analysis (COA)

The COA is the manufacturer’s Certificate of Compliance (COC) including all applicable test results required by the specifications.

1.2.10 Certificate of Compliance (COC)

The manufacturer’s certification stating that materials or assemblies furnished fully comply with the requirements of the contract. Provide signed COC by the manufacturer’s authorized representative. The COC may also be referred to as the Bill of Lading.

1.2.11 Screenings

Screenings are a uniformly sized, fine, sandy material with some silt particles. The term screening is used to designate the finer fraction of crushed stone that accumulates after primary and secondary crushing and separation on a No. 4 sieve. Screenings commonly range in particle size from 1/8 in down to finer than No. 200 sieve. The size distribution, particle shape, and other physical properties can be somewhat different from one quarry location to another, depending on the geological source of the rock quarried, the crushing equipment used, and the method used for coarse aggregate separation. Screenings generally contain freshly fractured faces, have a fairly uniform gradation, and do not usually contain large quantities of plastic fines.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Local/Regional Materials

SD-06 Test Reports

Sampling and Testing

SD-07 Certificates

Certificates Of Compliance (COC)

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect the materials delivered to the site for contamination and damage. Unload and store the materials with minimal handling.Do not allow asphalt emulsions to freeze or boil during transport or storage. Asphalt emulsions, if allowed to freeze or boil, may cause the asphalt emulsion to break. Remove this material from site if allowed to freeze or boil.

1.5 ENVIRONMENTAL REQUIREMENTS

Apply bituminous coat only when the surface to receive the bituminous coat is dry. A limited amount of moisture (approximately 0.03 gallon/square yard) can be sprayed on the surface of unbound material when prime coat is used to improve coverage and penetration of asphalt material. Apply bituminous coat only when the atmospheric temperature in the shade is 40 degrees F or above and when the temperature has not been below 35 degrees F for the 12 hours prior to application, unless otherwise directed.

PART 2 PRODUCTS

2.1 PRIME COAT MATERIAL

Provide asphalt, tack and prime materials, conforming to one of the following grades:

2.1.1 Emulsified Asphalt

Provide emulsified asphalt conforming to ASTM D977, Type SS-1 SS-1h ASTM D2397/D2397M, Type CSS-1 CSS-1h. Asphalt emulsion can be diluted up to 1 part water to 1 part emulsion for prime coat use. Where prime coats are to be diluted, certify the dilution was done in accordance with the specific dilution requirements for each product and for each load of material used.

2.2 TACK COAT MATERIAL

2.2.1 Emulsified Asphalt

Provide emulsified asphalt conforming to ASTM D977, Type MS-1 HFMS-1 SS-1 SS1h ASTM D2397/D2397M, Type CRS-1 CSS-1 CSS-1h.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

Immediately before applying the bituminous coat, remove all loose material, dirt, clay, or other objectionable material from the surface to be treated by means of a power broom or blower supplemented with hand brooms. Apply treatment only when the surface is dry and clean.

3.2 APPLICATION TEMPERATURE

3.2.1 Viscosity Relationship

Apply bituminous material at a temperature that will provide a viscosity between 10.0 and 60.0 seconds, Saybolt Furol in accordance with ASTM D88/D88M or between 20 and 120 centistokes in accordance with ASTM D2170/D2170M. Furnish the temperature viscosity relation to the Contracting Officer.

3.2.2 Temperature Ranges

The viscosity requirements determine the application temperature to be used. Table 2 presents a normal range of application temperatures. If Table 2 is different than the manufacturer's recommendation, use the manufacturer's recommendation.

Table 2

Tack Coat or Prime Coat Application Temperatures

Cutback Asphalt	
MC-70, RC-70(1)	120-225 degrees F
MC-250, RC-250(1)	165-270 degrees F
Asphalt Emulsion	
Cationic Emulsified Asphalt	130-170 degrees F
Anionic Emulsified Asphalt	150-180 degrees F
Non-Ionic Emulsified Asphalt	150-180 degrees F
Asphalt Binder	
All Grades	275-350 degrees F(2)

(1) Some temperatures within these ranges provided may exceed the flash point for certain rapid cure cutbacks. Care should be taken in their heating.

Table 2
Tack Coat or Prime Coat Application Temperatures
(2) Max temperature may be increased to 375 degrees F if recommended by the manufacturer to facilitate uniform application free of equipment clogging issues when hard base asphalt is used.

3.3 APPLICATION

3.3.1 General

Following preparation and subsequent inspection of the surface, apply the prime coat or tack coat with the distributor at the specified rate with uniform distribution over the surface to be treated. Properly treat all areas and spots, not capable of being sprayed with the distributor, with the hand spray. Until the succeeding layer of pavement is placed, maintain the surface by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, spread clean dry sand to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment are permitted within 25 feet of heating, distributing, and transferring operations of cutback materials. Prevent all traffic, except for paving equipment used in constructing the surfacing, from using the underlying material, whether primed or not, until the surfacing is completed.

3.3.2 Prime Coat

Apply the prime coat at locations shown on the Drawings only when the underlying material meets the specified material density requirements, and the moisture content is within 2 percent of optimum moisture. Application should be achieved within the limits of the temperature described in paragraph ENVIRONMENTAL REQUIREMENTS and quantities to achieve the rate of residual asphalt shown in Table 3a. At the time of priming, ensure that the base is firm, unyielding and in such condition that no undue distortion will occur. Ensure the prime coat adheres to the underlying material. Apply the prime coat material using a bituminous distributor. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, spread building paper on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper and to ensure that all sprayers will operate at full force on the surface to be treated. Immediately after application, remove and discard the building paper. If blotter aggregate is used, lightly sweep the area with a power broom, or other approved means, to remove any excess blotter aggregate.

Table 3a		
Prime Coat Application Rates		
Surface Type	Product Type	Rate (gal/yd^2)
Unbound Layers	Emulsion(1)	0.05 - 0.12 (residual rate)
	Cutback Asphalt	0.08 - 0.18 (shot rate)
(1) Emulsion prime coats may be diluted up-to a 1 to 1 dilution rate.		

3.3.3 Tack Coat

Immediately following the preparation of the surface for treatment, apply the tack coat by means of the distributor, within the limits of the temperature described in paragraph ENVIRONMENTAL REQUIREMENTS and in quantities to achieve the rate of residual application rates shown in Table 3b. Ensure the surface is clean and dry. Apply tack coat at the locations shown on the Drawings sufficiently in advance of placing the asphalt mixture to permit breaking and initial stages of curing. Do not apply tack coat so far in advance that it might lose its adhesiveness as a result of being covered with dust or other foreign material. When using a spray paver with appropriate tack coat products, tack coat breaking requirements do not apply. Dilution of tack coat is prohibited. A tack coat should be applied to every bound surface (asphalt or concrete pavement) that is being overlaid with asphalt mixture and at transverse and longitudinal joints. Apply the bituminous material so that uniform distribution is obtained over the entire surface to be treated. Treat lightly coated areas and spots missed by the distributor by spraying with a hand wand or using other approved method. To obtain uniform application of the tack coat, at the junction of previous and subsequent applications, spread building paper on the surface for a sufficient distance back from the ends of each application to start and stop the tack coat on the paper and to ensure that all sprayers will operate at full force on the surface to be treated. Immediately after application, remove and discard the building paper. If blotter aggregate is used, lightly sweep with a power broom, or other approved means, to remove any excess blotter aggregate. Maintain and protect the treated surface from damage until the succeeding course of pavement is placed.

Table 3b		
Tack Coat Application Rates(1,3,4)		
Surface Type	Residual Rate (gal/yd^2)	Approximate Bar Rate Undiluted(2) (gal/yd^2)
New Asphalt (between layers)	0.02 - 0.05	0.03 - 0.07

Table 3b		
Tack Coat Application Rates[1,3,4]		
Surface Type	Residual Rate (gal/yd^2)	Approximate Bar Rate Undiluted[2] (gal/yd^2)
Existing Asphalt	0.04 - 0.07	0.06 - 0.11
Milled Surface	0.04 - 0.08	0.06 - 0.12
Portland Cement Concrete	0.03 - 0.05	0.05 - 0.08
(1) Dilution of tack coat is not allowed		
(2) Assumes emulsion is 33 percent water and 67 percent asphalt		
(3) Emulsified asphalt is prohibited to be applied at application rates over 0.12 gal/yd^2		
(4) Residual rate is the same as bar rate when using hot-applied asphalt binders. Use residual rate tolerances as shown above for target when using hot-applied asphalt binders.		

3.4 FIELD QUALITY CONTROL

Certificates of compliance (COC) for asphalt materials delivered will be obtained and checked to ensure that specification requirements are met. Quantities of applied material will be determined. Prime coat materials when emulsions are used can be diluted on site with potable water up to 1 part water to 1 part emulsion, as long as the residual rate is still being met. Do not dilute tack coat materials. If requested by the Government, obtain samples of the bituminous material under the supervision of the Government per paragraph SAMPLING and send for analysis.

3.4.1 Sampling and Testing

Furnish certified copies of the manufacturer's test reports indicating temperature-viscosity relationship for asphalt materials and compliance with applicable specified requirements, not less than 5 days before the material is required in the work.

3.4.2 Sampling

Unless otherwise specified, sample bituminous material in accordance with ASTM D140/D140M.

3.5 PRIME COAT SET PERIOD

Allow the prime coat to set without being disturbed for a period of at least 48 hoursor longer, as may be necessary to attain penetration into the treated course. Furnish and spread enough blotter aggregate to effectively blot up excess bituminous material.

3.6 TACK COAT BREAKING PERIOD

Following application of an emulsified asphalt tack coat and prior to application of the succeeding layer of asphalt mixture, allow emulsified asphalt tack coats to break. No break period is required for cutback or hot-applied asphalt binder tack coat products.

3.7 TRAFFIC CONTROLS

Maintain the primed surface and tacked surface in good condition until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

3.8 ATTACHMENT

ATTACHMENT 1: Estimating Application Rate of Bituminous Distributors

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SECTION 32 13 13.06

PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES
05/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2019) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A775/A775M	(2022) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A966/A966M	(2015; R 2020) Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM C31/C31M	(2024b) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2023) Standard Specification for Concrete Aggregates
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2022) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2024) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989/C989M	(2022) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1077	(2024) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

ASTM C1542/C1542M	(2019) Standard Test Method for Measuring Length of Concrete Cores
ASTM C1567	(2023) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D2995	(2023) Determining Application Rate of Bituminous Distributors

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA QC 3	(2015) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Curing Materials

Reinforcement

Epoxy Resin

Dowel Bars

Expansion Joint Filler

SD-04 Samples

Test Section;

SD-05 Design Data

Mix Design Report; G, RO

SD-06 Test Reports

Concrete Slump Tests

Concrete Uniformity

Flexural Strength

Air Content

SD-07 Certificates

Batch Tickets

NRMCA Certificate Of Conformance

1.3 QUALITY CONTROL

1.3.1 NRMCA Certificate of Conformance

Provide a batching and mixing plant consisting of a stationary-type central mix plant, including permanent installations and portable or relocatable plants installed on stable foundations. Provide a plant designed and operated to produce concrete within the specified tolerances, with a minimum capacity of 50 cubic yards per hour. The batching and mixing plant shall be no more than 30 minutes haul time from the placing site. Submit NRMCA Certificate of Conformance that conforms to the requirements of NRMCA QC 3 including provisions addressing:

1. Material Storage and Handling
2. Batching Equipment
3. Central Mixer
4. Ticketing System
5. Delivery System

1.3.2 Qualifications

1.3.2.1 Laboratory Accreditation

Perform sampling and testing using an approved commercial testing laboratory or on-site facilities that are accredited in accordance with ASTM C1077. Do not start work requiring testing until the facilities have been inspected and approved. The Government will inspect all laboratories requiring validation for equipment and test procedures prior to the start of any concreting operations for conformance to ASTM C1077. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. Maintain this certification for the duration of the project.

1.3.2.2 Field Technicians

Provide field technicians meeting one of the following criteria:

a. Have at least one National Ready Mixed Concrete Association (NRMCA) certified concrete craftsman and at least one American Concrete Institute (ACI) Flatwork Finisher Certified craftsman on site, overseeing each placement crew during all concrete placement.

b. Have no less than three NRMCA certified concrete installers and at least two American Concrete Institute (ACI) Flatwork Finisher Certified installers on site working as members of each placement crew during all concrete placement.

1.3.3 Batch Tickets

Submit batch tickets for each load of ready-mixed concrete in accordance with ASTM C94/C94M.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver concrete paving in accordance with ASTM C94/C94M.

1.5 ACCEPTANCE

1.5.1 Tolerances

Acceptance of Portland cement concrete pavement is based on compliance with the tolerances presented in Table 1. Remove and replace concrete pavement represented by the failing tests or submit repair plan for approval.

Table 1

Measurement	Tolerance
PLASTIC CONCRETE	
Slump	plus 0, minus 1.5 inches
Air Content	plus/minus 1.5 percent
Flexural Strength	No individual specimen less than 100 psi below specified strength.
HARDENED CONCRETE	
Grade	plus/minus 0.05 feet from plan
Smoothness	No abrupt change exceeding 1/8 inch
Straightedge	Not more than 1/8 in for roads. Not more than 1/4 in for open storage areas.
Profilograph	Not more than 9 inches/mile
Thickness	minus 3/4 inch for pavement equal to/greater than 8 inches thick minus 1/2 inch for pavement less than 8 inches thick.

Table 1	
Edge Slump	85 percent less than 1/4 inch and 100 percent less than 3/8 inch.

1.5.2 Test Section

Construct a minimum 400 square feet test section to demonstrate typical joints, surface finish, texture, color, thickness, and standard of workmanship using the mixture proportions, materials, and equipment as proposed for the project. Test in accordance with requirements in FIELD QUALITY CONTROL.

When a test section does not meet one or more of the tolerances in Table 1, remove and reconstruct the test section. If the test section is acceptable, it may be incorporated into the project.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

2.1.1.1 Portland Cement

Conforming to ASTM C150/C150M, TypeII or III for high early concrete, low alkali .

2.1.1.2 Blended Cement

Provide blended cement conforming to ASTM C595/C595M, Type IP or IS, including the optional requirement for mortar expansion and sulfate soundness. Provide pozzolan added to the Type IP blend consisting of ASTM C618 Class F or Class N and that is interground with the cement clinker. Include in written statement from the manufacturer that the amount of pozzolan in the finished cement does not vary more than plus or minus 5 mass percent of the finished cement from lot to lot or within a lot. The percentage and type of mineral admixture used in the blend are not allowed to change from that submitted for the aggregate evaluation and mixture proportioning. The requirements of paragraph Supplementary Cementitious Materials (SCM) Content do not apply to the SCM content of blended cement.

2.1.1.3 Fly Ash and Pozzolan

Conforming to ASTM C618, Type F, or N, with a loss on ignition not exceeding 3 percent. Include test results in accordance with ASTM C618.

2.1.1.4 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) conforming to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age at least 95 percent of the control specimens.

b. The average particle size not exceeding 6 microns.

c. Loss on ignition not exceeding 3 percent.

2.1.1.5 Silica Fume

Provide silica fume that conforms to ASTM C1240, including the optional limits on reactivity with cement alkalis. Provide silica fume as a dry, densified material or as a slurry. Provide the services of a manufacturer's technical representative, experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume, at no expense to the Government. This representative is required to be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume.

2.1.1.6 Slag

Conforming to ASTM C989/C989M, Slag Cement Grade 100 or 120. Include test results in accordance with ASTM C989/C989M.

2.1.1.7 Supplementary Cementitious Materials (SCM) Content

Include one of the SCMs listed in Table 2 within the range specified therein, whether or not the aggregates are found to be reactive in accordance with the paragraph Alkali Reactivity Test.

TABLE 2
SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

Supplementary Cementitious Material	Minimum Content (percent)	Maximum Content (percent)
Class N Pozzolan and Class F Fly Ash		
SiO2 + Al2O3 + Fe2O3 greater than 70 percent	25	35
SiO2 + A12O3 + Fe2O3 greater than 80 percent	20	35
SiO2 + A12O3 + Fe2O3 greater than 90 percent	15	35
UFFA and UFP	7	16
GGBF Slag	40	50

2.1.2 Water

Water conforming to ASTM C1602/C1602M.

2.1.3 Aggregate

2.1.3.1 Durability

Evaluate and test all fine and coarse aggregates to be used in all concrete for durability in accordance with ASTM C88. Provide fine and coarse aggregates with a maximum of 18 percent loss when subjected to 5 cycles using Magnesium Sulfate or a maximum of 12 percent loss when

subjected to 5 cycles of Sodium Sulfate.

2.1.3.2 Alkali Reactivity Test

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate reactivity. Test all size groups and sources proposed for use.

a. Evaluate the fine and coarse aggregates separately, using ASTM C1260. Reject individual aggregates with test results that indicate an expansion of greater than 0.08 percent after 28 days of immersion in 1N NaOH solution, or perform additional testing as follows: utilize the proposed low alkali portland cement, blended cement, or SCM in combination with each individual aggregate. Test in accordance with ASTM C1567. Determine the quantity that meets all the requirements of these specifications and that lowers the expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Base the mixture proportioning on the highest percentage of SCM required to mitigate ASR-reactivity.

b. If any of the above options does not lower the expansion to less than 0.08 percent after 28 days of immersion in a 1N NaOH solution, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing for evaluation and acceptance.

2.1.3.3 Fine Aggregates

Conforming to the quality and gradation of ASTM C33/C33M.

2.1.3.4 Coarse Aggregates

Coarse aggregate consisting of crushed or uncrushed gravel, crushed stone, or a combination thereof. Provide aggregates, as delivered to the mixers, consisting of clean, hard, uncoated particles. Wash coarse aggregate sufficient to remove dust and other coatings. Provide fine aggregate consisting of natural sand, manufactured sand, or a combination of the two, and composed of clean, hard, durable particles. Provide both coarse and fine aggregates meeting the requirements of ASTM C33/C33M.

a. Gradation: Provide coarse aggregate with a nominal maximum size of 1.5 inches. Grade and provide the individual aggregates in two or more size groups meeting the individual grading requirements of ASTM C33/C33M, Size No. 4 (1.5 to 0.75 inch) and Size No. 67 (0.75 inch to No. 4).

b. Quality: Conforming to ASTM C33/C33M, Class 4M.

2.1.4 Chemical Admixtures

2.1.4.1 Water Reducing Admixtures

Provide admixture conforming to ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures. ASTM C494/C494M Type S specific performance admixtures and ASTM C1017/C1017M flowable admixtures are not allowed.

2.1.4.2 Air Entraining Admixture

Conforming to ASTM C260/C260M: Air-entraining.

2.1.4.3 High Range Water Reducing Admixture

ASTM C494/C494M Type F and G high range water reducing admixtures are not allowed.

2.1.5 Reinforcement

2.1.5.1 Dowel Bars

Dowel bars conforming to ASTM A615/A615M, Grade 60 for plain billet-steel bars of the size and length indicated. Remove all burrs and projections from the bars.

2.1.5.2 Tie Bars

Billet or axle steel deformed bars conforming to ASTM A615/A615M or ASTM A966/A966M Grade 40 or Grade 60. Epoxy coat in accordance with ASTM A775/A775M.

2.1.5.3 Reinforcement

Deformed steel bar mats conforming to ASTM A184/A184M. Bar reinforcement conforming to ASTM A615/A615M or ASTM A966/A966M, Grade 60. Epoxy coat in accordance with ASTM A775/A775M.

2.1.6 Curing Materials

Provide curing materials consisting of:

2.1.6.1 White-Burlap-Polyethylene Sheet

Conforming to ASTM C171, 0.004 inch thick white opaque polyethylene bonded to 10 oz/linear yard (40 inch) wide burlap.

2.1.6.2 Liquid Membrane-Forming Compound

Conforming to ASTM C309, white pigmented, Type 2, Class B, free of paraffin or petroleum.

2.1.6.3 Liquid Chemical Sealer-Hardener Compound

Compound consisting of magnesium fluosilicate which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions.

2.1.7 Biodegradable Form Release Agent

Provide form release agent that is colorless and biodegradable. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent with a minimum of 87 percent biobased material and does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

2.1.8 Epoxy Resin

Provide epoxy-resin materials that consist of two-component materials conforming to the requirements of ASTM C881/C881M, Class as appropriate for each application temperature to be encountered, except that in addition, the materials meet the following requirements:

a. Type IV, Grade 3, for use for embedding dowels and anchor bolts.

b. Type III, Grade as approved, for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar.

c. Type IV, Grade 1, for use for injecting cracks.

d. Type V, Grade as approved, for bonding freshly mixed portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete.

2.1.9 Joint Materials

2.1.9.1 Expansion Joint Materials

Provide preformed expansion joint filler material conforming to ASTM D1751. Provide expansion joint filler that is 3/4 inch thick, unless otherwise indicated, and provided in a single full depth piece.

2.1.9.2 Slip Joint Material

Provide slip joint material that is 1/4 inch thick expansion joint filler, unless otherwise indicated, conforming to paragraph EXPANSION JOINT MATERIAL.

2.2 MIX DESIGN

Proportion concrete mix in accordance with ACI 211.1 except as modified herein.

2.2.1 Specified Concrete Properties

2.2.1.1 Flexural Strength

Provide concrete with a minimum flexural strength of 650 psi at 28 days of age.

2.2.1.2 Air Entrainment

Provide an entrained air content of 6.0 percent.

2.2.1.3 Slump

For fixed form and hand placement, provide a maximum slump of 3 inches. For slipformed pavement, at the start of the project, select a maximum allowable slump which will produce in-place pavement meeting the specified tolerances for control of edge slump. The selected slump is applicable to both pilot and fill-in lanes.

2.2.1.4 Water/Cementitious Materials Ratio

Maximum allowable water-cementitious material ratio is 0.40. The water-cementitious material ratio is based on absolute volume equivalency, where the ratio is determined using the weight of cement for a cement only mix, or using the total volume of cement plus pozzolan converted to an equivalent weight of cement by the absolute volume equivalency method described in ACI 211.1.

2.2.2 Mix Design Report

Perform trial design batches, mixture proportioning studies, testing, and include test results demonstrating that the proposed mixture proportions produce concrete of the qualities indicated. An existing mix design may be submitted if developed within the previous 12 months. Submit test results in a mix design report to include:

a. Coarse and fine aggregate gradations and plots.

b. Coarse and fine aggregate quality test results, include deleterious materials and ASR testing.

c. Mill certificates for cement and supplemental cementitious materials.

d. Certified test results for all proposed admixtures.

e. Specified flexural strength, slump, and air content.

f. Recommended proportions and volumes for proposed mixture and each of three trial water-cementitious materials ratios.

g. Individual beam breaks.

h. Flexural strength summaries and plots.

i. Historical record of test results, documenting production standard deviation (if available).

j. Narrative discussing methodology on how the mix design was developed.

2.2.3 Mix Verification

Mix verification tests may be performed by the Government. Provide quantities of cementitious materials, aggregates and admixtures as requested.

2.3 EQUIPMENT

2.3.1 Batching and Mixing

Provide stationary or truck mixers. Provide a batch plant conforming to ASTM C94/C94M and as specified. Do not weigh water or measure cumulatively with another ingredient. Batch all concrete materials in accordance with ASTM C94/C94M requirements. Verify batching, mixers, mixing time, permitted reduction of mixing time, and concrete uniformity in accordance with the requirements of ASTM C94/C94M, and document in the initial weekly QC Report. Do not use truck mixers for mixing slipformed concrete. Provide only truck mixers designed for mixing or transporting paving concrete with extra large blading and rear opening specifically for

low-slump paving concrete and conforming to the requirements of ASTM C94/C94M.

2.3.2 Transporting Equipment

Provide transporting equipment in conformance with ASTM C94/C94M and as specified herein. Transport concrete to the paving site in rear-dump trucks, in truck mixers designed with extra large blading and rear opening specifically for low slump concrete, or in agitators. Do not permit bottom-dump trucks for delivery of concrete.

2.3.3 Delivery Equipment

When concrete transport equipment cannot operate on the paving lane, provide side-delivery transport equipment consisting of self-propelled moving conveyors to deliver concrete from the transport equipment and discharge it in front of the paver. Do not permit front-end loaders, dozers, or similar equipment to distribute the concrete.

2.3.4 Paver-Finisher

Provide a heavy-duty, self-propelled paver-finisher machine designed specifically for paving and finishing high quality pavement and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one pass. Equip the paver-finisher with a full width "knock-down" auger, capable of operating in both directions, which will evenly spread the fresh concrete in front of the screed or extrusion plate. Gang-mount immersion vibrators at the front of the paver on a frame equipped with suitable controls so that all vibrators can be operated at any desired depth within the slab or completely withdrawn from the concrete. Automatically control the vibrators so they will be immediately stopped as forward motion of the paver ceases. Space the immersion vibrators across the paving lane as necessary to properly consolidate the concrete, but limit the clear distance between vibrators not to exceed 30 inches, and the outside vibrators not to exceed 12 inches from the edge of the lane. Vibrators may be pneumatic, gas driven, or electric, and operated at frequencies within the concrete between 6,000 and 7,000 vibrations per minute, with an amplitude of vibration such that noticeable vibrations occur at 1.5 foot radius when the vibrator is inserted in the concrete to the depth specified. Equip the paver-finisher with a transversely oscillating screed or an extrusion plate to shape, compact, and smooth the surface.

2.3.4.1 Paver-Finisher with Fixed Forms

Equip the paver-finisher with wheels designed to ride the forms, keep it aligned with the forms, and to prevent deformation of the forms.

2.3.4.2 Slipform Paver-Finisher

Provide a track-mounted slipform paver-finisher with automatic controls and padded tracks. Electronically reference horizontal alignment to a taut wire guideline. Electronically reference vertical alignment on both sides of the paver to a taut wire guideline, to an approved laser control system, or to a ski operating on a completed lane. Do not control from a slope-adjustment control or from the underlying material.

2.3.4.3 Other Types of Finishing Equipment

Heavy duty vibratory truss screeds may be approved for use if successfully demonstrated on the test section to consolidate the slab full depth and without segregation. Clary screeds, rotating tube floats, or laser screeds will not be allowed on the project. Provide hand floats that are not less than 12 feet long and 6 inches wide and stiffened to prevent flexing and warping.

2.3.4.4 Work Bridge

Provide a self-propelled work bridge capable of spanning the paving lane and supporting the workmen without excessive deflection.

2.3.5 Texturing Equipment

Provide texturing equipment as specified below.

2.3.5.1 Fabric Drag

Clean, reasonably new burlap or Artificial turf fabricated of a plastic material measuring from 3 to 10 feet long, 2 feet wider than the width of the pavement, and securely attached to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. Select dimension of burlap drag so that at least 3 feet of the material is in contact with the pavement.

2.3.5.2 Deep Texturing Equipment

Provide texturing equipment consisting of a stiff bristled broom or or a comb with spring wire tines or spring strips which will produce true, even grooves. Mount this drag in a wheeled frame spanning the paving lane and constructed to mechanically pull the drag in a straight line across the paving lane perpendicular to the centerline.

2.3.6 Curing Equipment

Provide equipment for applying membrane-forming curing compound mounted on a self-propelled frame that spans the paving lane. Constantly agitate the curing compound reservoir mechanically (not air) during operation and provide a means for completely draining the reservoir. Provide a spraying system that consists of a mechanically powered pump which maintains constant pressure during operation, an operable pressure gauge, and either a series of spray nozzles evenly spaced across the lane to provide uniformly overlapping coverage or a single spray nozzle which is mounted on a carriage which automatically traverses the lane width at a speed correlated with the forward movement of the overall frame. Protect all spray nozzles with wind screens. Calibrate the spraying system in accordance with ASTM D2995, Method A, for the rate of application required in subpart CURING AND PROTECTION. Provide hand-operated sprayers powered by compressed air supplied by a mechanical air compressor. Immediately replace curing equipment if it fails to apply an even coating of compound at the specified rate.

2.3.7 Sawing Equipment

Provide equipment for sawing joints and for other similar sawing of concrete consisting of standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required

alignment. Provide diamond tipped blades. If demonstrated to operate properly, abrasive blades may be used. Provide spares as required to maintain the required sawing rate. Early-entry saws may be used, subject to demonstration and approval. No change to the initial sawcut depth is permitted.

2.3.8 Straightedge

Furnish one 12 foot straightedge constructed of aluminum or magnesium alloy, having blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Provide handles for operation on the pavement.

PART 3 EXECUTION

3.1 PREPARATION FOR PAVING

3.1.1 Weather Limitations

When windy conditions during paving appear probable, have equipment and material at the paving site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete.

3.1.1.1 Inclement Weather

Do not commence placing operations when heavy rain or other damaging weather conditions appear imminent. At all times when placing concrete, maintain on-site sufficient waterproof cover and means to rapidly place it over all unhardened concrete or concrete that might be damaged by rain. Suspend placement of concrete whenever rain, high winds, or other damaging weather commences to damage the surface or texture of the placed unhardened concrete, washes cement out of the concrete, or changes the water content of the surface concrete. Immediately cover and protect all unhardened concrete from the rain or other damaging weather. Completely remove and replace any slab damaged by rain or other weather full depth, by full slab width, to the nearest original joint.

3.1.1.2 Hot Weather

Maintain required concrete temperature in accordance with ACI 305R to prevent evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing, place concrete during cooler night time hours, or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Water is not allowed to be added after the initial introduction of mixing water except, when on arrival at the job site, the slump is less than specified and the water-cement ratio is less than that given as a maximum in the approved mixture. Additional water may be added to bring the slump within the specified range provided the approved water-cement ratio is not exceeded. Inject water into the head of the mixer (end opposite the discharge opening) drum under pressure, and turn the drum or blades a minimum of 30 additional revolutions at mixing speed. The addition of water to the batch at any later time is not allowed. After placement, use fog spray, apply monomolecular film, or use other suitable means to reduce the evaporation rate. Start curing when surface of fresh concrete is sufficiently hard to permit curing without damage. Cool underlying material by sprinkling lightly with water before placing concrete. Follow practices found in ACI 305R.

3.1.1.3 Prevention of Plastic Shrinkage Cracking

During weather with low humidity, and particularly with high temperature and appreciable wind, develop and institute measures to prevent plastic shrinkage cracks from developing. If plastic shrinkage cracking occurs, halt further placement of concrete until protective measures are in place to prevent further cracking. Periods of high potential for plastic shrinkage cracking can be anticipated by use of ACI 305R. In addition to the protective measures specified in the previous paragraph, the concrete placement may be further protected by erecting shades and windbreaks and by applying fog sprays of water, the addition of monomolecular films, or wet covering. Apply monomolecular films after finishing is complete, do not use in the finishing process. Immediately commence curing procedures when such water treatment is stopped.

3.1.1.4 Cold Weather

Do not place concrete when ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. When authorized, when concrete is likely to be subjected to freezing within 24 hours after placing, heat concrete materials so that temperature of concrete when deposited is between 65 and 80 degrees F. Methods of heating materials are subject to approval. Do not heat mixing water above 165 degrees F. Remove lumps of frozen material and ice from aggregates before placing aggregates in mixer. Follow practices found in ACI 306R.

3.1.2 Conditioning of Underlying Material

Verify the underlying material, upon which concrete is to be placed is clean, damp, and free from debris, waste concrete or cement, frost, ice, and standing or running water. Prior to setting forms or placement of concrete, verify the underlying material is well drained and has been satisfactorily graded by string-line controlled, automated, trimming machine and uniformly compacted in accordance with the applicable Section of these specifications. Test the surface of the underlying material to crown, elevation, and density in advance of setting forms or of concrete placement using slip-form techniques. Trim high areas to proper elevation. Fill and compact low areas to a condition similar to that of surrounding grade, or fill with concrete monolithically with the pavement. Low areas filled with concrete are not to be cored for thickness to avoid biasing the average thickness used for evaluation and payment adjustment. Rework and compact any underlying material disturbed by construction operations to specified density immediately in front of the paver. If a slipform paver is used, continue the same underlying material under the paving lane beyond the edge of the lane a sufficient distance that is thoroughly compacted and true to grade to provide a suitable trackline for the slipform paver and firm support for the edge of the paving lane.

3.1.3 Forms

Use steel forms, except that wood forms may be used for curves having a radius of 150 feet or less, and for fillets. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. Provide forms with the base width not less than eight-tenths of the vertical height of the form, except that for forms 8 inches or less in vertical height, provide forms with a base width not

less than the vertical height of the form. Provide wood forms adequate in strength and rigidly braced for curves and fillets. Set forms on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Do not set forms on blocks or on built-up spots of underlying material. Before placing the concrete, coat the contact surfaces of forms except existing pavement sections where bonding is required, with a non-staining mineral oil, non-staining form coating compound, biodegradable form release agent, or two coats of nitro-cellulose lacquer. When using existing pavement as a form, clean existing concrete and then coat with asphalt emulsion bondbreaker before concrete is placed. Check and correct grade elevations and alignment of the forms immediately before placing concrete.

3.1.4 Reinforcement

3.1.4.1 Dowel Bars

Install dowels with horizontal and vertical alignment plus or minus 1 inch. Except as otherwise specified, maintain location of dowels within a skew alignment of 1/4 inch over 1 foot length. Reject coatings which are perforated, cracked or otherwise damaged. While handling avoid scuffing or gouging of the coatings. Maintain dowels in position during concrete placement and curing. Before concrete placement, thoroughly grease the entire length of each dowel secured in a dowel basket or fixed form.

3.1.4.2 Tie Bars

Install bars, accurately aligned horizontally and vertically, and to the tolerances shown on the drawings, at indicated locations.

3.1.4.3 Setting Slab Reinforcement

Position reinforcement on suitable chairs prior to concrete placement. At expansion, contraction and construction joints, place the reinforcement as indicated. Clean reinforcement free of mud, oil, scale or other foreign materials. Place reinforcement accurately and wire securely. Lap splices 12 inches minimum. Maintain the bar spacing from ends and sides of slabs and joints as indicated.

3.2 MEASURING, MIXING, CONVEYING, AND PLACING CONCRETE

3.2.1 Measuring

Conform to ASTM C94/C94M.

3.2.2 Mixing

Conform to ASTM C94/C94M, except as modified herein. Begin mixing within 30 minutes after cement has been added to aggregates. When the air temperature is greater than 85 degrees F, place concrete within 60 minutes. With approval, a hydration stabilizer admixture meeting the requirements of ASTM C494/C494M Type D, may be used to extend the placement time to 90 minutes. Additional water may be added to bring slump within required limits as specified in ASTM C94/C94M, provided that the specified water-cement ratio is not exceeded.

3.2.3 Conveying

Conform to ASTM C94/C94M.

3.2.4 Placing

Do not exceed a free vertical drop of 5 feet from the point of discharge. Deposit concrete either directly from the transporting equipment or by conveyor on to the pre-wetted subgrade or subbase, unless otherwise specified. Deposit the concrete between the forms to an approximately uniform height. Place concrete continuously at a uniform rate, without damage to the grade and without unscheduled stops except for equipment failure or other emergencies. If an unscheduled stop occurs within 10 feet of a previously placed expansion joint, remove concrete back to joint, repair any damage to grade, install a construction joint and continue placing concrete only after cause of the stop has been corrected.

3.3 PAVING

Construct pavement with paving and finishing equipment utilizing fixed forms orslipforms.

3.3.1 Paving Plan

Submit for approval a paving plan identifying the following items:

a. A description of the placing and protection methods proposed when concrete is to be placed in or exposed to hot, cold, or rainy weather conditions.

b. A detailed paving sequence plan and proposed paving pattern showing all planned construction joints.

c. Plan and equipment proposed to control alignment of formed or sawn joints within the specified tolerances.

3.3.2 Required Results

Operate the paver-finisher to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. Adjust the paver-finishing operation to produce a surface finish free of irregularities, tears, voids of any kind, and other discontinuities, with only a minimum of paste at the surface. Do not permit multiple passes of the paver-finisher. Produce a finished surface requiring no hand finishing, other than the use of cutting straightedges, except in very infrequent instances. Do not apply water, other than true fog sprays (mist), to the concrete surface during paving and finishing.

3.3.3 Operation

When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), make provisions to prevent damage to the previously constructed pavement, including keeping the existing pavement surface free of debris, and placing rubber mats beneath the paver tracks. Operate transversely oscillating screeds and extrusion plates to overlap the existing pavement the minimum possible, but in no case more than 8 inches.

3.3.4 Consolidation

Immediately after spreading concrete, consolidate full depth with internal type vibrating equipment along the boundaries of all slabs regardless of slab thickness, and interior of all concrete slabs. For pavements less than 10 inches thick, operate vibrators at mid-depth parallel with or at a slight angle to the base course. For thicker pavements, angle vibrators toward the vertical, with vibrator tip preferably about 2 inches above the base course, and top of vibrator a few inches below pavement surface. Automatically control the vibrators or tamping units in front of the paver so that they stop immediately as forward motion ceases. Limit duration of vibration to that necessary to produce consolidation of concrete. Do not permit excessive vibration. Vibrate concrete in small, odd-shaped slabs or in locations inaccessible to the paver mounted vibration equipment with a hand-operated immersion vibrator operated from a bridge spanning the area. Do not operate vibrators at one location for more than 15 seconds. Do not use vibrators to transport or spread the concrete.

3.3.5 Fixed Form Paving

Spread and strike off concrete with with the paver. Shape the concrete to the specified and indicated cross section in one pass, and finish the surface and edges so that only a very minimum amount of hand finishing is required. Use single spud hand vibrators to consolidate the concrete adjacent to fixed forms as required to achieve a void-free formed edge. Do not allow vibrators to contact reinforcement, forms, or the grade during vibration.

3.3.6 Slipform Paving

Shape the concrete to the specified and indicated cross section in one pass, and finish the surface and edges so that only a very minimum amount of hand finishing is required. Do not install dowels by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete.

3.4 JOINTS

3.4.1 Contraction Joints

Hold dowels andtie bars in longitudinal and transverse contraction joints within the paving lane securely in place by means of rigid metal basket assemblies. Weld the dowels and tie bar to the assembly or hold firmly by mechanical locking arrangements that will prevent them from becoming distorted during paving operations. Anchor the basket assemblies securely in the proper location.

3.4.2 Construction Joints - Fixed Form Paving

Install dowels and tie bars by the bonded-in-place method, supported by means of devices fastened to the forms. Do not permit installation by removing and replacing in preformed holes.

3.4.3 Dowels Installed In Hardened Concrete

Install by bonding the dowels into holes drilled into the hardened concrete. Drill holes into the hardened concrete approximately 1/8 inch greater in diameter than the dowels. Bond the dowels in the drilled holes using epoxy resin injected at the back of the hole before installing the

dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel is not permitted. Hold the dowels in alignment at the collar of the hole, after insertion and before the epoxy resin hardens, by means of a suitable metal or plastic collar fitted around the dowel. Check the vertical alignment of the dowels by placing the straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel. Where tie bars are required in longitudinal construction joints of slipform pavement, install bent tie bars at the paver, in front of the transverse screed or extrusion plate. If tie bars are required, construct a standard keyway and install the bent tie bars into the plastic concrete through a 26 gauge thick metal keyway liner. Do not install tie bars in preformed holes. Protect the keyway liner and maintain in place and become part of the joint. Before placement of the adjoining paving lane, straighten the tie bars, without spalling the concrete around the bar.

3.5 FINISHING CONCRETE

Start finishing operations immediately after placement of concrete. Use finishing machine, except hand finishing may be used in emergencies and for concrete slabs in inaccessible locations or of such shapes or sizes that machine finishing is impracticable. Immediately halt any operations which produce more than 1/8 inch of mortar-rich surface (defined as deficient in plus U.S. No. 4 sieve size aggregate) and modify the equipment, mixture, or procedures. Finish pavement surface on both sides of a joint to the same grade. Finish formed joints from a securely supported transverse bridge. Provide hand finishing equipment for use at all times.

3.5.1 Machine Finishing

Strike off and screed concrete to the required slope and cross-section by a power-driven transverse finishing machine. A transverse rotating tube or pipe is not permitted. Maintain elevation of concrete such that, when consolidated and finished, pavement surface will be adequately consolidated and at the required grade. Equip finishing machine with a screed which is readily and accurately adjustable for changes in pavement slope and compensation for wear and other causes. Do not permit excessive operation over an area, which will result in an excess of mortar and water being brought to the surface.

3.5.1.1 Equipment Operation

Maintain the travel of machine on the forms without lifting, wobbling, or other variation of the machine which tend to affect the precision of concrete finish. Keep the tops of the forms clean by a device attached to the machine. Maintain a uniform ridge of concrete ahead of the front screed for its entire length.

3.5.1.2 Joint Finish

Before concrete is hardened, correct edge slump of pavement, exclusive of edge rounding, in excess of 0.25 inches. Finish concrete surface on each side of construction joints to the same plane, and correct deviations before newly placed concrete has hardened.

3.5.1.3 Hand Finishing

Strike-off and screed surface of concrete to elevations slightly above finish grade so that when concrete is consolidated and finished, the pavement surface is at the indicated elevation. Vibrate entire surface until required compaction and reduction of surface voids is secured with a strike-off template. After initial finishing, further smooth and consolidate concrete by means of hand-operated longitudinal floats.

3.5.2 Texturing

Before the surface sheen has disappeared and before the concrete hardens, provide a texture to the surface of the pavement as described herein. After curing is complete, thoroughly broom all textured surfaces to remove all debris. Finish the concrete in areas of recesses for tie-down anchors, lighting fixtures, and other outlets in the pavement to provide a surface of the same texture as the surrounding area.

3.5.2.1 Burlap Drag Finish

Before concrete becomes non-plastic, finish the surface of the slab by dragging a strip of clean, wet burlap on the surface. Drag the surface so as to produce a finished surface with a fine granular or sandy texture without leaving disfiguring marks. Keep the burlap clean and saturated during use.

3.5.2.2 Brooming

Finish the surface of the slab by brooming the surface with a new wire broom at least 18 inches wide. Gently pull the broom over the surface of the pavement from edge to edge just before the concrete becomes non-plastic. Slightly overlap adjacent strokes of the broom. Broom perpendicular to centerline of pavement so that corrugations produced will be uniform in character and width, and not more than 1/16 inch in depth. Maintain broomed surface free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidentally disturbing particles of coarse aggregate embedded near the surface.

3.5.2.3 Wire-Comb Texturing

Apply surface texture transverse to the pavement center line using a mechanical wire comb drag capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Overlap successive passes of the comb the minimum necessary to obtain a continuous and uniformly textured surface, with scores 1/16 to 3/16 inch deep, 1/16 to 1/8 inch wide, and spaced 3/8 inch apart.

3.5.3 Edging

At the time the concrete has attained a degree of hardness suitable for edging, carefully finish slab edges, including edges at formed joints, with an edge having a maximum radius of 1/8 inch. When brooming is specified for the final surface finish, edge transverse joints before starting brooming, then operate broom to obliterate as much as possible the mark left by the edging tool without disturbing the rounded corner left by the edger. Clean by removing loose fragments and soupy mortar from corners or edges of slabs which have crumbled and areas which lack sufficient mortar for proper finishing. Refill voids solidly with a

mixture of suitable proportions and consistency and refinish. Remove unnecessary tool marks and edges. Smooth remaining edges true to line.

3.6 CURING AND PROTECTION

Protect concrete adequately from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein. Do not use membrane-forming compound on surfaces where its appearance would be objectionable, on surfaces to be painted, where coverings are to be bonded to concrete, or on concrete to which other concrete is to be bonded.

3.6.1 Moist Curing

Maintain concrete to be moist-cured continuously wet for the entire curing period, or until curing compound is applied, commencing immediately after finishing. If forms are removed before the end of the curing period, provide curing on unformed surfaces, using suitable materials. Cure surfaces by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Provide burlap and mats that are clean and free from any contamination and completely saturated before being placed on the concrete. Lap sheets to provide full coverage. Provide an approved work system to ensure that moist curing is continuous 24 hours per day and that the entire surface is wet.

3.6.2 White-Burlap-Polyethylene Sheet

Wet entire exposed surface thoroughly with a fine spray of water, saturate burlap but do not have excessive water dripping off the burlap and then cover concrete with White-Burlap-Polyethylene Sheet, burlap side down. Lay sheets directly on concrete surface and overlap 12 inches. Make sheeting not less than 18 inches wider than concrete surface to be cured, and weight down on the edges and over the transverse laps to form closed joints. Repair or replace sheets when damaged during curing. Check daily to assure burlap has not lost all moisture. If moisture evaporates, resaturate burlap and re-place on pavement (limit re-saturation and re-placing to less than 10 minutes per sheet). Leave sheeting on concrete surface to be cured for at least 7 days.

3.6.3 Liquid Membrane-Forming Compound Curing

Apply compound immediately after surface loses its water sheen and has a dull appearance and before joints are sawed. Agitate curing compound thoroughly by mechanical means during use and apply uniformly in a two-coat continuous operation by suitable power-spraying equipment. Apply a total coverage for the two coats at least one gallon of undiluted compound per 200 square feet to produce a uniform, continuous, coherent film that will not check, crack, or peel and free from pinholes or other imperfections. The application of curing compound by hand-operated, mechanical powered pressure sprayers is permitted only on odd widths or shapes of slabs and on concrete surfaces exposed by the removal of forms. When the application is made by hand-operated sprayers, apply a second coat in a direction approximately at right angles to the direction of the first coat. Apply an additional coat of compound immediately to areas where film is defective. Respray concrete surfaces that are subject to heavy rainfall within 3 hours after curing compound has been applied in the same manner.

3.6.4 Protection of Treated Surfaces

After the initial saw cut is complete and the slurry has been removed, respray the area with curing compound or restore the white burlap polyethylene sheet to maintain a continuous curing environment in the area of the sawn joints. Keep concrete surfaces to which liquid membrane-forming compounds have been applied free from vehicular traffic and other sources of abrasion for not less than 72 hours. Foot traffic is allowed after 24 hours for inspection purposes. Maintain continuity of coating for entire curing period and repair damage to coating immediately.

3.7 FIELD QUALITY CONTROL

3.7.1 Sampling

Collect samples of fresh concrete in accordance with ASTM C172/C172M during each working day as required to perform tests specified herein. Make test specimens in accordance with ASTM C31/C31M.

3.7.2 Consistency Tests

Perform concrete slump tests in accordance with ASTM C143/C143M. Take samples for slump determination from concrete during placement. Perform tests at the beginning of a concrete placement operation and for each batch (minimum) or every 20 cubic yards (maximum) of concrete to ensure that specification requirements are met. In addition, perform tests each time test beams are made.

3.7.3 Flexural Strength Tests

Test for flexural strength in accordance with ASTM C78/C78M. Fabricate and cure four test specimens in accordance with ASTM C31/C31M for each set of tests. Test two specimens at 7 days, and the other two at 28 days. Concrete strength will be considered satisfactory when the minimum of the 28-day test results equals or exceeds the specified 28-day flexural strength, and no individual strength test is less than the tolerance indicated on Table 1. If the ratio of the 7-day strength test to the specified 28-day strength is less than 65 percent, make necessary adjustments for conformance. Fabricate, cure and test a minimum of one set of four beams for each shift of concrete placement. Remove concrete which is determined to be defective, based on the strength acceptance criteria therein, and replace with acceptable concrete.

3.7.4 Air Content Tests

Test air-entrained concrete for air content at the same frequency as specified for slump tests. Determine percentage of air in accordance with ASTM C231/C231M on samples taken during placement of concrete in forms.

3.7.5 Surface Testing

Use the profilograph method for all longitudinal testing, except for paving lanes less than 200 feet in length. Use the straightedge method for transverse testing, for longitudinal testing where the length of each pavement lane is less than 200 feet, and at the ends of the paving limits for the project. Smoothness requirements do not apply over crowns, drainage structures, or similar penetrations. Maintain detailed notes of the testing results and submit a copy to the Government after each day's

testing.

3.7.5.1 Straightedge Testing Method

Test the surface of the pavement with the straightedge to identify all surface irregularities exceeding the tolerances specified in Table 1. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines approximately 15 feet apart. Hold the straightedge in contact with the surface and move ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface, in the area between these two high points.

3.7.5.2 "Bumps" (Must Grind Areas)

Reduce any bumps ("must grind" areas) shown on the profilograph trace which exceed 0.4 inch in height by diamond grinding until they do not exceed 0.3 inch when retested. Taper such diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding.

3.7.6 Plan Grade Testing and Conformance

Within 5 days after each day's paving, test the finished surface of the pavement area by running lines of levels at intervals corresponding with every longitudinal and transverse joint to determine the elevation at each joint intersection. Record the results of this survey and submit a copy to the Government at the completion of the survey.

3.7.7 Edge Slump

Test the pavement surface to determine edge slump immediately after the concrete has hardened sufficiently to permit walking thereon. Perform testing with a minimum 12 foot straightedge to reveal irregularities exceeding the edge slump tolerance specified in Table 1. Determine the vertical edge slump at each free edge of each slipformed paving lane constructed. Place the straightedge transverse to the direction of paving and the end of the straightedge located at the edge of the paving lane. Record measurements at 5 to 10 foot spacings, as directed, commencing at the header where paving was started. Initially record measurements at 5 foot intervals in each lane. When no deficiencies are present after 5 measurements, the interval may be increased. The maximum interval is 10 feet. When any deficiencies exist, return the interval to 5 feet. In addition to the transverse edge slump determination above, at the same time, record the longitudinal surface smoothness of the joint on a continuous line 1 inch back from the joint line using the minimum 12 foot straightedge advanced one-half its length for each reading. Perform other tests of the exposed joint face to ensure that a uniform, true vertical joint face is attained. Properly reference all recorded measurements in accordance with paving lane identification and stationing, and submit a report within 24 hours after measurement is made. Identify areas requiring replacement within the report.

3.7.8 Test for Pavement Thickness

Take full depth cores of 4 inch diameter of concrete pavement every 1200 square feet in accordance with ASTM C42/C42M. Measure thickness in

accordance with ASTM C1542/C1542M. Record and submit testing, inspection, and evaluation of each core for surface paste, uniformity of aggregate distribution, segregation, voids, cracks, and depth of reinforcement or dowel (if present). Moisten the core with water to visibly expose the aggregate and take a minimum of three photographs of the sides of the core, rotating the core approximately 120 degrees between photographs. Include a ruler for scale in the photographs. Submit plan view of location for each core.

3.7.9 Reinforcement

Inspect reinforcement prior to installation to verify it is free of loose flaky rust, loose scale, oil, mud, or other objectionable material.

3.7.10 Dowels

Inspect dowel placement prior to placing concrete to verify that dowels are of the size indicated, and are spaced, aligned and painted and oiled as specified. Do not permit dowels to exceed the tolerances shown in paragraph: DOWEL BARS.

-- End of Section --

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SECTION 32 16 19

CONCRETE CURBS, GUTTERS AND SIDEWALKS
05/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2017) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2022) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2024b) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2024a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2022) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C920	(2018) Standard Specification for Elastomeric Joint Sealants

ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D5893/D5893M	(2016) Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2017) Standard And Commentary Accessible and Usable Buildings and Facilities

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete

SD-06 Test Reports

Field Quality Control

1.3 EQUIPMENT, TOOLS, AND MACHINES

1.3.1 General Requirements

Plant, equipment, machines, and tools used in the work will be subject to approval and must be maintained in a satisfactory working condition at all times. Use equipment capable of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Discontinue using equipment that produces unsatisfactory results. Allow the Contracting Officer access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.3.2 Slip Form Equipment

Slip form paver or curb forming machines, will be approved based on trial use on the job and must be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in one pass.

1.4 ENVIRONMENTAL REQUIREMENTS

1.4.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection must be approved in writing. Approval will be contingent upon full conformance with the following provisions. Prepare and protect the underlying material so that it is entirely free of frost when the concrete is deposited. Heat mixing water and aggregates as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating must be approved. Use only aggregates that are free of ice, snow, and frozen lumps before entering the mixer. Provide covering or other means as needed to maintain the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.4.2 Placing During Warm Weather

The temperature of the concrete as placed must not exceed 85 degrees F except where an approved retarder is used. Cool the mixing water and aggregates as necessary to maintain a satisfactory placing temperature. The placing temperature must not exceed 95 degrees F at any time.

PART 2 PRODUCTS

2.1 CONCRETE

Provide concrete conforming to the applicable requirements of Section 03 30 00 CAST-IN-PLACE CONCRETEexcept as otherwise specified. Concrete must have a minimum compressive strength of 3500 psi at 28 days. Size of aggregate must not exceed 1-1/2 inches. Submit copies of certified delivery tickets for all concrete used in the construction.

2.1.1 Air Content

Use concrete mixtures that have an air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

Use concrete with a slump of 3 inches plus or minus 1 inch for hand placed concrete or 1 inch plus or minus 1/2 inch for slipformed concrete as determined in accordance with ASTM C143/C143M.

2.1.3 Reinforcement Steel

Use reinforcement bars conforming to ASTM A615/A615M. Use wire mesh reinforcement conforming to ASTM A1064/A1064M.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Use impervious sheet materials conforming to ASTM C171, type optional, except that polyethylene film, if used, must be white opaque.

2.2.2 Burlap

Use burlap conforming to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

Use white pigmented membrane-forming curing compound conforming to ASTM C309, Type 2.

2.3 CONCRETE PROTECTION MATERIALS

Use concrete protection materials consisting of a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Use hard-pressed fiberboard contraction joint filler for curb and gutter.

2.4.2 Expansion Joint Filler, Premolded

Onless otherwise indicated, use 1/2 inch thick premolded expansion joint filler conforming to ASTM D1751 or ASTM D1752.

2.5 JOINT SEALANTS

Use cold-applied joint sealant conforming to ASTM C920 or ASTM D5893/D5893M.

2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Use wood or steel forms that are straight and of sufficient strength to resist springing during depositing and consolidating concrete.

2.6.1 Wood Forms

Use forms that are surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Use forms with a nominal length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness.

2.6.2 Steel Forms

Use channel-formed sections with a flat top surface and welded braces at each end and at not less than two intermediate points. Use forms with

interlocking and self-aligning ends. Provide flexible forms for radius forming, corner forms, form spreaders, and fillers as needed. Use forms with a nominal length of 10 feet and that have a minimum of 3 welded stake pockets per form. Use stake pins consisting of solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.3 Sidewalk Forms

Use sidewalk forms that are of a height equal to the full depth of the finished sidewalk.

2.6.4 Curb and Gutter Forms

Use curb and gutter outside forms that have a height equal to the full depth of the curb or gutter. Use rigid forms for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

2.7 Detectable Warning System

Detectable Warning Systems shown on the Contract plans are to meet requirements of ICC A117.1 - Section 705.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

Construct subgrade to the specified grade and cross section prior to concrete placement.

3.1.1 Sidewalk Subgrade

Place and compact the subgrade in accordance with Section 31 00 00 EARTHWORK. Test the subgrade for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

Place and compact the subgrade in accordance with Section 31 00 00 EARTHWORK and Section 32 11 23 AGGREGATE BASE COURSE . Test the subgrade for grade and cross section by means of a template extending the full width of the curb and gutter. Use subgrade materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

Maintain subgrade in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade must be in a moist condition when concrete is placed. Prepare and protect subgrade so that it is free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Use additional stakes and braces at corners, deep sections, and radius bends, as required. Use clamps, spreaders, and braces where required to ensure rigidity in the forms. Remove forms in a manner that will not injure the concrete. Do not use bars or heavy tools against the concrete when removing the forms. Promptly and satisfactorily repair concrete found to be defective after form removal. Clean forms and coat with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment must be checked with a 10 foot straightedge. Sidewalks must have a transverse slope of 1/4 inch per foot Unless otherwise indicated, construct sidewalks that are located adjacent to curbs with the low side adjacent to the curb. Do not remove side forms less than 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

Remove forms used along the front of the curb not less than 2 hours nor more than 6 hours after the concrete has been placed. Do not remove forms used along the back of curb until the face and top of the curb have been finished, as specified for concrete finishing. Do not remove gutter forms while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks must be of the thickness indicated. Use a strike-off guided by side forms after concrete has been placed in the forms to bring the surface to proper section to be compacted. Consolidate concrete by tamping and spading or with an approved vibrator. Finish the surface to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. Produce a scored surface by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

Finish all slab edges, including those at formed joints, with an edger having a radius of 1/8 inch. Edge transverse joints before brooming. Eliminate the flat surface left by the surface face of the edger with brooming. Clean and solidly fill corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing with a

properly proportioned mortar mixture and then finish.

3.3.4 Surface and Thickness Tolerances

Finished surfaces must not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Place concrete to the required section in a single lift. Consolidate concrete using approved mechanical vibrators. Curve shaped gutters must be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Float and finish exposed surfaces with a smooth wood float until true to grade and section and uniform in texture. Brush floated surfaces with a fine-hair brush using longitudinal strokes. Round the edges of the gutter and top of the curb with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the front curb surface, while still wet, in the same manner as the gutter and curb top. Finish the top surface of gutter and entrance to grade with a wood float.

3.4.4 Joint Finishing

Finish curb edges at formed joints as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces must not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.5 SIDEWALK JOINTS

Construct sidewalk joints to divide the surface into rectangular areas. Space transverse contraction joints at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and continuous across the slab. Construct longitudinal contraction joints along the centerline of all sidewalks 10 feet or more in width. Construct transverse expansion joints at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, install transverse expansion joints as indicated. Form expansion joints around structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

3.5.1 Sidewalk Contraction Joints

Form contraction joints in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness. Unless otherwise approved or indicated, either use a jointer to cut the groove or saw a groove in the hardened concrete with a power-driven saw. Construct sawed joints by sawing a groove in the concrete with a 1/8 inch blade. Provide an ample supply of saw blades on the jobsite before concrete placement is started. Provide at least one standby sawing unit in good working order at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Form expansion joints using 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D1752 or building paper. Hold joint filler in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, round joint edges using an edging tool having a radius of 1/8 inch. Remove any concrete over the joint filler. At the end of the curing period, clean the top of expansion joints and fill with cold-applied joint sealant. Use joint sealant that is gray or stone in color. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Apply joint sealing material only when the concrete at the joint is surface dry and atmospheric and concrete temperatures are above 50 degrees F. Immediately remove any excess material on exposed surfaces of the concrete and clean the concrete surfaces.

3.5.3 Reinforcement Steel Placement

Accurately and securely fasten reinforcement steel in place with suitable supports and ties before the concrete is placed.

3.6 CURB AND GUTTER JOINTS

Construct curb and gutter joints at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Construct contraction joints directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length.

a. Construct contraction joints (except for slip forming) by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Remove separators as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

b. When slip forming is used, cut the contraction joints in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb and gutter, using a power-driven saw. Cut the contraction joint to a depth of at least one-fourth of the gutter/curb depth using a 1/8 inch saw blade.

3.6.2 Expansion Joints

Form expansion joints by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Construct expansion joints in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement using the same type and thickness of joints as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, provide expansion joints at least 1/2 inch in width at intervals not less than 30 feet nor greater than 120 feet. Seal expansion joints immediately following curing of the concrete or as soon thereafter as weather conditions permit. Seal expansion joints and the top 1 inch depth of curb and gutter contraction-joints with joint sealant. Thoroughly clean the joint opening before the sealing material is placed. Do not spill sealing material on exposed surfaces of the concrete. Concrete at the joint must be surface dry and atmospheric and concrete temperatures must be above 50 degrees F at the time of application of joint sealing material. Immediately remove excess material on exposed surfaces of the concrete and clean concrete surfaces.

3.7 CURING AND PROTECTION

3.7.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete must be on hand and ready for use before actual concrete placement begins. Protect concrete as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

Cover the entire exposed surface with two or more layers of burlap. Overlap mats at least 6 inches. Thoroughly wet the mat with water prior to placing on concrete surface and keep the mat continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

Wet the entire exposed surface with a fine spray of water and then cover with impervious sheeting material. Lay sheets directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. Use sheeting that is not less than 18-inches wider than the concrete surface to be cured. Secure sheeting using heavy wood planks or a bank of moist earth placed along edges and laps in the sheets. Satisfactorily repair or replace sheets that are torn or otherwise damaged during curing. Sheeting must remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

Apply a uniform coating of white-pigmented membrane-curing compound to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Coat formed surfaces immediately after the forms are removed and in no case longer than 1 hour

after the removal of forms. Do not allow concrete surface to dry before application of the membrane. If drying has occurred, moisten the surface of the concrete with a fine spray of water and apply the curing compound as soon as the free water disappears. Apply curing compound in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet/gallon for the total of both coats. Apply the second coat in a direction approximately at right angles to the direction of application of the first coat. The compound must form a uniform, continuous, coherent film that will not check, crack, or peel and must be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes. Respray concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied by the method and at the coverage specified above. Respray areas where the curing compound is damaged by subsequent construction operations within the curing period. Take precautions necessary to ensure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. Tightly seal the top of the joint opening and the joint groove at exposed edges before the concrete in the region of the joint is resprayed with curing compound. Use a method used for sealing the joint groove that prevents loss of moisture from the joint during the entire specified curing period. Provide approved standby facilities for curing concrete pavement at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Adequately protect concrete surfaces to which membrane-curing compounds have been applied during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, remove debris and backfill, grade, and compact the area adjoining the concrete to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Protect completed concrete from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Remove and reconstruct concrete that is damaged for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Dispose of removed material as directed.

3.7.4 Protective Coating

Apply a protective coating of linseed oil mixture to the exposed-to-view concrete surface after the curing period, if concrete will be exposed to de-icing chemicals within 6 weeks after placement. Moist cure concrete to receive a protective coating.

3.7.4.1 Application

Complete curing and backfilling operation prior to applying two coats of protective coating. Concrete must be surface dry and clean before each application. Spray apply at a rate of not more than 50 square yards/gallon for first application and not more than 70 square yards/gallon for second application, except that the number of applications and coverage for each

application for commercially prepared mixture must be in accordance with the manufacturer's instructions. Protect coated surfaces from vehicular and pedestrian traffic until dry.

3.7.4.2 Precautions

Do not heat protective coating by direct application of flame or electrical heaters and protect the coating from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Do not apply material at ambient or material temperatures lower than 50 degrees F.

3.8 FIELD QUALITY CONTROL

Submit copies of all test reports within 24 hours of completion of the test.

3.8.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and additional tests to ensure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

Take concrete samples in accordance with ASTM C172/C172M not less than once a day nor less than once for every 250 cubic yards of concrete placed. Mold cylinders in accordance with ASTM C31/C31M for strength testing by an approved laboratory. Each strength test result must be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

3.8.2.2 Air Content

Determine air content in accordance with ASTM C173/C173M or ASTM C231/C231M. Use ASTM C231/C231M with concretes and mortars made with relatively dense natural aggregates. Make two tests for air content on randomly selected batches of each class of concrete placed during each shift. Make additional tests when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. Notify the placing foreman if results are out of tolerance. The placing foreman must take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Perform two slump tests on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Perform additional tests when excessive variation in the workability of the concrete is noted or when excessive

crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

Determine the anticipated thickness of the concrete prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, construct the subgrade true to grade prior to concrete placement. The thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

Provide finished surfaces for each category of the completed work that are uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, reduce high areas either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete must not exceed 5 percent of the area of any integral slab, and the depth of grinding must not exceed 1/4 inch. Remove and replace pavement areas requiring grade or surface smoothness corrections in excess of the limits specified.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Contracting Officer and deficiencies in appearance will be identified. Remove and replace areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work.

3.10 DETECTABLE WARNING SYSTEM

Install Detectable Warning Systems required by Contract plans in accordance with ICC A117.1, Section 705, and by manufacturers' installation instructions.

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SECTION 32 31 13

CHAIN LINK FENCES AND GATES
11/21

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A392	(2011; R 2022a) Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM F567	(2014a; R 2019) Standard Practice for Installation of Chain Link Fence
ASTM F626	(2014; R 2019) Standard Specification for Fence Fittings
ASTM F883	(2013; R 2022) Standard Performance Specification for Padlocks

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-F-191/2	(Rev E) Fencing, Wire and Post, Metal (Chain-Link Fence Gates)
FS RR-F-191/3	(2023; Rev F) Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop DrawingsLocation of Gate, Corner, End, and Pull Posts; Erection/Installation Drawings; G, RO

SD-03 Product Data

Fence Assembly; G, RO

Gate Assembly; G, RO

Gate Hardware and Accessories; G, RO

SD-07 Certificates

Certificates of Compliance

SD-08 Manufacturer's Instructions

Fence Assembly

Gate Assembly

Hardware Assembly

Accessories

1.3 QUALITY CONTROL

1.3.1 Certificates of Compliance

Submit certificates of compliance in accordance with the applicable reference standards and descriptions of this section for the following:

a. Zinc coating

d. Fabric

f. Gate hardware and accessories

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Submit reports of listing chain-link fencing and accessories regarding

weight in ounces for zinc coating.

Submit manufacturer's catalog data for complete fence assembly, gate assembly, hardware assembly and accessories.

2.2 GATES

FS RR-F-191/2; Type I, single swing . Shape and size of gate frame, as indicated. Framing and bracing members, as indicated. Provide gate frames and braces of minimum sizes listed in FS RR-F-191/3 for each Class and Grade, except that steel pipe frames are a minimum of 1.90 inches o.d., 0.120 inches minimum wall thickness and aluminum pipe frames and intermediate braces are 1.869 inches o.d. minimum, 0.940 lb/ft of length.

2.2.1 Gate Post

Provide gate posts for supporting each gate leaf in minimum sizes listed in FS RR-F-191/3 for each material class and grade. Gate post material class, grade and finish to match other fence posts.

2.2.2 Gate Frame

Provide gate frame assembly that is welded or assembled with special malleable or pressed-steel fittings and rivets to provide rigid connections.

2.2.3 Gate Bracing

Provide diagonal cross-bracing, consisting of 3/8 inch diameter adjustable-length truss rods on welded gate frames, where necessary to obtain frame rigidity without sag or twist. Provide nonwelded gate frames with diagonal bracing.

2.2.4 Padlocks

Provide padlocks conforming to ASTM F883, with chain.

2.2.5 Gate Hardware and Accessories

Provide gate hardware and accessories that conforms to ASTM A392 and ASTM F626, and as specified. Coating for steel latches, stops, hinges, keepers, and accessories, is galvanized.

2.3 MATERIALS

2.3.1 Zinc Coating

Provide zinc-coated ferrous metal components and accessories that are factory coated after fabrication, except as otherwise specified.

For galvanizing field repairs, provide material that is cold-applied zinc-rich coating conforming to ASTM A780/A780M.

2.3.2 Concrete

Provide concrete conforming to ASTM C94/C94M, and obtaining a minimum 28-day compressive strength of 3,000 psi.

2.3.3 Grout

Provide grout of proportions one part portland cement to three parts clean, well-graded sand and a minimum amount of water to produce a workable mix.

PART 3 EXECUTION

Submit manufacturer's erection/installation drawings and instructions that detail proper assembly and materials in the design for fence, gate, hardware and accessories.

Provide complete installation conforming to ASTM F567.

3.1 INSTALLATION

3.1.1 Security

Install new chain link fencing, remove existing fencing, and perform related work to provide continuous security for facility. Schedule and fully coordinate work with Contracting Officer and cognizant Security Officer.

3.1.2 Fence Installation

Install fence on prepared surfaces to line and grade indicated. Install fence in accordance with fence manufacturer's written installation instructions except as modified herein.

3.1.2.1 Post Spacing

Provide line posts spaced equidistantly apart, not exceeding 10 feet on center. Provide gate posts spaced as necessary for size of gate openings. Do not exceed 500 feet on straight runs between braced posts. Provide corner or pull posts, with bracing in both directions, for changes in direction of 15 degrees or more, or for abrupt changes in grade. Submit drawings showing location of gate, corner, end, and pull posts.

3.1.2.2 Top and Bottom Tension Wire

Install top and bottom tension wires before installing chain-link fabric, and pull wires taut. Place top and bottom tension wires within 8 inches of respective fabric line.

3.1.3 Excavation

Provide excavations for post footings which are in virgin or compacted soil, of minimum sizes as indicated. Space footings for line posts 10 feet on center maximum and at closer intervals when indicated, with bottoms of the holes approximately 3 inches below the bottoms of the posts. Set

bottom of each post not less than 36 inches below finished grade when in firm, undisturbed soil. Set posts deeper, as required, in soft and problem soils and for heavy, lateral loads.

When solid rock is encountered near the surface, drill into the rock at least 12 inches for line posts and at least 18 inches for end, pull, corner, and gate posts. Drill holes at least 1 inch greater in diameter than the largest dimension of the placed post. If solid rock is below the soil overburden, drill to the full depth required except that penetration into rock need not exceed the minimum depths specified above.

3.1.4 Setting Posts

Remove loose and foreign materials from holes and moisten the soil prior to placing concrete. Provide tops of footings that are trowel finished and sloped or domed to shed water away from posts. Set hold-open devices, sleeves, and other accessories in concrete.

Keep exposed concrete moist for at least 7 calendar days after placement or cured with a membrane curing material, as approved. Maintain vertical alignment of posts in concrete construction until concrete has set.

3.1.4.1 Earth and Bedrock

Provide concrete bases of dimensions indicated on the manufactures installation drawings. Compact concrete to eliminate voids, and finish to a dome shape.

3.1.4.2 Bracing

Brace gate, corner, end, and pull posts to nearest post with a horizontal brace used as a compression member, placed at least 12 inches below top of fence, and a diagonal tension rod.

3.1.4.3 Tolerances

Provide posts that are straight and plumb within a vertical tolerance of 1/4 inch after the fabric has been stretched. Provide fencing and gates that are true to line with no more than 1/2 inch deviation from the established centerline between line posts. Repair defects as directed.

3.1.5 Concrete Strength

Provide concrete that has attained at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than 7 calendar days after placement, before rails, tension wire, or fabric are installed. Do not stretch fabric and wires or hang gates until the concrete has attained its full design strength.

3.1.6 Top Rails

Provide top rails that run continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by the fencing manufacturer.

3.1.7 Center Rails

Provide single piece center rails between posts set flush with posts on the fabric side, using special offset fittings where necessary.

3.1.8 Brace Assembly

Provide bracing assemblies at end and gate posts and at both sides of corner and pull posts, with the horizontal brace located at midheight of the fabric.

Install brace assemblies so posts are plumb when the diagonal rod is under proper tension. Provide two complete brace assemblies at corner and pull posts where required for stiffness and as indicated.

3.1.9 Tension Wire Installation

Install tension wire by weaving them through the fabric and tying them to each post with not less than 7-gauge galvanized wire or by securing the wire to the fabric with 10-gauge ties or clips spaced 24 inches on center.

3.1.10 Fabric Installation

Provide fabric in single lengths between stretch bars with bottom barbs placed approximately 1-1/2 inches above the ground line. Pull fabric taut and tied to posts, rails, and tension wire with wire ties and bands.

Install fabric on the security side of fence, unless otherwise directed. Ensure fabric remains under tension after the pulling force is released.

3.1.11 Stretcher Bar Installation

Thread stretcher bars through or clamped to fabric 4 inches on center and secured to posts with metal bands spaced 15 inches on center.

3.1.12 Gate Installation

Install gates plumb, level, and secure, with full opening without interference. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricated where necessary.

3.1.13 Tie Wires

Provide tie wires that are U-shaped to the pipe diameters to which attached. Twist ends of tie wires not less than two full turns and bent so as not to present a hazard.

3.1.14 Fasteners

Install nuts for tension bands and hardware on the side of the fence opposite the fabric side. Peen ends of bolts to prevent removal of nuts.

3.1.15 Zinc-Coating Repair

Clean and repair galvanized surfaces damaged by welding or abrasion, and cut ends of fabric, or other cut sections with specified galvanizing repair material applied in strict conformance with the manufacturer's printed instructions.

3.1.16 Accessories Installation

3.1.16.1 Post Caps

Install post caps as recommended by the manufacturer.

3.1.16.2 Padlocks

Provide padlocks for gate openings and provide chains that are securely attached to gate or gate posts. Provide padlocks keyed alike, and provide two keys for each padlock.

3.2 CLOSEOUT ACTIVITIES

Remove waste fencing materials and other debris from the work site.

-- End of Section --

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SEEDING
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C602	(2020) Agricultural Liming Materials
ASTM D4427	(2018) Standard Classification of Peat Samples by Laboratory Testing
ASTM D4972	(2018) Standard Test Methods for pH of Soils

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1940; R 1988; R 1998) Federal Seed Act
DOA SSIR 42	(1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.2 DEFINITIONS

1.2.1 Stand of Seed Mix

95 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 32 05 33 LANDSCAPE ESTABLISHMENT applies to this section for plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment; G, RO

Fertilizer

Herbicide; G, RO

Seed Mix; G, DO

Include physical characteristics, and recommendations from manufacturer.

SD-06 Test Reports

Topsoil Composition Tests (reports and recommendations); G, RO

Seed Lab Analysis for each species in the seed mix prior to purchase; G, DO

SD-07 Certificates

Herbicide; G, RO

State and Federal Certification and Approval for seedSeed; G, DO

SD-08 Manufacturer's Instructions

Erosion Control Materials

SD-11 Closeout Submittals

Plant Establishment Period

Calendar time period for the plant establishment period. When there is more than one establishment period, the boundaries of the planted areas covered for each period shall be described.

Contractor shall include as-built documentation of tree locations and planting boundaries for shrubs, seeding, wetland sod, and plugs.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 Fertilizer, Gypsum, Sulfur, Iron, and Lime Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer, gypsum, sulphur, iron, and lime may be furnished in bulk with certificate indicating the above information.

1.5.2 Herbicide

Weed killer (herbicide) shall be delivered to the site in the original, unopened containers bearing legible labels indicating the Environmental

Protection Agency (EPA) registration number and the manufacturer's registered uses. All herbicides shall have the label fully displayed at all times. The Contractor shall comply with all applicable parts of 29 CFR 1910 to assure safe working conditions for contract personnel and a safe environment for occupants of Air Force facilities. The Contractor shall dispose of all empty herbicide containers and other non-reusable material in accordance with federal and local regulations.

1.5.3 Storage

1.5.3.1 Seed, Fertilizer, Gypsum, Sulfur, Iron, and Lime Storage

Store in cool, dry locations away from contaminants.

1.5.3.2 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Seed

Apply seed within twenty four hours after seed bed preparation.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Classification

Provide State and/or Federal-certified seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. Certified copies of the material certificates shall include the following:

a. Seed. Dealer's statement of seed analysis shall state for each seed type the name and address of the seller, lot number, test date, seed type and variety with botanical and common name, origin, the guaranteed percentage or purity and germination,weed seed content, pounds of pure live seed (PLS) per species, and total PLS pounds and bulk pounds of the seed mix. Signed statement certifying that seed mixtures have been tested within the last 6 months prior to the date of delivery for seed type, and weed content. Seed and seed labels shall conform to all current State and Federal regulations and shall be subject to the testing provisions of the Association of Official Seed Analysis.

b. Delivery Tickets and Analysis Seed Tags: Submit delivery tickets or copy of the seed invoice and all tags removed from each bag

of seed to the Contracting Officer's Representative. Tags attached to the bags of seed will not be removed until the bag is opened on site at the time of seeding.

c. Contractor shall submit name(s), address(es) and phone number(s) of the proposed seed testing lab(s).

2.1.2 Seed Lab Analysis

2.1.2.1 General Requirement

All seed will be sampled and will be tested at an approved seed testing facility. Seed sampling and testing will be completed and the results accepted by the Contracting Officer's Representative prior to delivery to the project site. Acceptance of, or the waiving of the inspection and tests of any seed will in no way relieve the Contractor of the responsibility for furnishing seed meeting the requirements of the contract(s). The seed
delivered shall be subject to further inspection and tests as may be determined by the Contracting Officer's Representative to be necessary to ascertain conformance with the specifications stated herein. The Contractor shall pay the cost of the seed sampling and seed test analysis.

2.1.2.2 Approved Seed Testing Facilities

a. Approved facilities include Official State Seed Laboratories in Arizona, California, Colorado, Idaho, Montana, Nevada, Oregon, South Dakota, North Dakota, Nebraska Crop Improvement, Utah, Washington, and Wyoming. Approved private seed laboratories include the following: AV Seed Testing, Agri-Quality Testing, Inc., Agri-Seed Testing Services, Mid-West
Seed Testing Services, Ransom Seed Laboratory, and J&T Green.

b. Contractor will not use a seed lab with which they have close business connections such as a financial interest, controlling interest, or
associated interests.

Contractor must list at least two different seed labs, in the submittal section, where they prefer tests to be performed. Every attempt will be made to honor Contractor's first lab choice. If lab workload and backlog are problematic to timely seed analysis completion, then an alternate lab may be utilized. The Official State Seed Laboratories will coordinate with the Contractor on an alternate lab choice.

2.1.2.3 Sampling Methods

The contractor will be responsible for sampling seed.

a. Samples will be drawn from each lot of seed delivered in accordance with the methods prescribed in the Journal of Seed Technology, Rules for Testing Seeds, Association of Official Seed Analysts (AOSA). http://www.aosaseed.com

b. The contractor must contact the Contracting Officer's Representative prior to seed testing. Samples must be drawn as prescribed by AOSA by a Certified Sampler.

c. The quantity of seed in the official sample, fully representative of

each lot of seed furnished, must be enough to provide seed for: one sample bag to a seed testing lab and two sample bags to the Contracting Officer's Representative, for retesting if necessary.

2.1.2.4 Testing

The seed furnished will be tested for purity (inert matter, other crop, and weed seed), germination (TZ), Pure Live Seed (PLS) and All States Noxious
Weed Exam. All percent germination will be determined by a TZ test. One test will be completed on each lot of seed delivered. A second test will be conducted if the first test does not meet specifications. The two seed tests may be averaged and used to determine percent PLS, weed content, and other crop. In the event a third test is needed, the Contracting
Officer's Representative will have the seed tested from the seed samples provided to determine final acceptance or rejection. No seed mixing shall be done until seed test results are accepted by the Contracting Officer's Representative.

2.1.2.5 Reporting Seed Test Results

The contractor will complete and submit seed testing results. The seed tests must be dated after bid award.

a. Faxed or scanned seed lab analysis reports for each lot shall be sent to the Contracting Officer's Representative. Contractor shall provide Contracting Officer's Representative a list of labs completing seed analysis. Seed tests are the property of the Corps of Engineers. Acceptance or Rejection of Seed

b. The Contracting Officer's Representative reserves the right to accept or reject seed. All seed is subject to visual inspection, including moisture, upon delivery to the project location. The Contracting Officer's Representative may reject a seed lot based on visual inspection.

c. If the Contracting Officer's Representative rejects the seed, the contractor is required to replace the lot of seed with seed meeting all seed quality testing standards. Additional seed tests are at the contractor's cost.

d. Rejected Seed: If tested seed is rejected after delivery, the Contractor must promptly replace such seed at the Contractor's cost, including delivery costs.

2.1.3 Planting Dates

Planting Season	Planting Dates
Fall	Oct 1 - Nov 30
Winter	Feb 1 - April 15
Temporary Seeding	At substantial completion

2.1.4 Seed Mix and Purity

Scientific Name	Common Name	Growth Season	Growth Form	% Mix	Lb/ac (PLS^
Grasses					
Bouteloua gracilis	Blue grama	Warm	Sod	25	1.8
Sporobolus cryptandrus	Sand dropseed	Warm	Bunch	20	0.2
Bouteloua curtipendul	Sideoats grama	Warm	Sod	20	6.3
Pascopyrum smithii	Western wheatgrass	Cool	Sod	15	8.2
Bouteloua dactyloides	Buffalogra	Warm	Sod	10	10.7
Distichlis spicata	Inland saltgrass	Warm	Sod	5	0.6
Herbaceous/Wildflowers					
Artemisia frigida	Pasture sage			1	0.01
Gaillardia aristata	Blanket flower			1	0.5
Ratibida columnifera	Prairie coneflower			1	0.1
Dalea (Petalostem purpurea	Purple prairieclo			1	0.3
Linum lewisii	Blue flax			1	0.4
TOTAL PLS POUNDS/ACRE				100	29.11

1^PLS= Pure Live Seed

a. Permanent seed mixes and application rates shall be as described. Seed must be delivered premixed by the supplier. Under no circumstances will field mixing of seed be acceptable.

b. Submit a copy of the proposed seed mixes, listing species common name, variety, scientific name, percent of mix, and PLS pounds per acre to the DO for approval prior to beginning work.

c. Deviations from the approved seed mixes require approval from the DO prior to ordering seed. Approval will not be given for deviations due to cost of individual species.

d. Temporary Cover Seed: Temporary cover crop for seeding finished graded surfaces outside of allowable permanent seeding dates and for surface erosion control or over-seeding shall be seeded to milo (Certified) at a rate of 8 PLS (Pure Live Seed) pounds per acre from mid-May to early June. Fall and winter temporary seeded species will be certified triticale (winter or spring variety as appropriate to time of year) at

15 PLS pounds per acre.

2.2 TOPSOIL

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph COMPOSITION. When available topsoil must be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph COMPOSITION. Additional topsoil must be furnished by the Contractor.

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH must be tested in accordance with ASTM D4972. Topsoil must be free of sticks, stones, roots, and other debris and objectionable materials. Other components must conform to the following limits:

pH value between 5.4 (min) to 7.0 (max).

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.3.1 Lime

Commercial grade limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602.

2.3.2 Aluminum Sulfate

Commercial grade.

2.3.3 Sulfur

100 percent elemental

2.3.4 Iron

100 percent elemental

2.3.5 Peat

Natural product of peat moss derived from a freshwater site and conforming to ASTM D4427. Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation.

2.3.6 Sand

Clean and free of materials harmful to plants.

2.3.7 Perlite

Horticultural grade.

2.3.8 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:

2.3.8.1 Particle Size

Minimum percent by weight passing:

No. 4 mesh screen	95
No. 8 mesh screen	80

2.3.8.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.3.9 Gypsum

Coarsely ground gypsum comprised of calcium sulfate dihydrate 80 percent, calcium 18 percent, sulfur 14 percent; minimum 96 percent passing through 20 mesh screen, 100 percent passing thru 16 mesh screen.

2.3.10 Calcined Clay

Calcined clay must be granular particles produced from montmorillonite clay calcined to a minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent must pass a No. 8 sieve; a minimum 99 percent must be retained on a No. 60 sieve; and material passing a No. 100 sieve must not exceed 2 percent. Bulk density: A maximum 40 pounds per cubic foot.

2.4 FERTILIZER

2.4.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

10 percent available nitrogen
20 percent available phosphorus
10 percent available potassium

2.5 MULCH

Mulch must be free from noxious weeds, mold, and other deleterious materials.

2.5.1 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay must be sterile, containing no fertile seed.

2.6 Herbicide, Insecticides, Fungicides, and Other Pesticides

Use of pesticides must comply with all applicable state and federal laws. Pesticides must be registered with the U.S. Environmental Protection Agency and applied by a certified applicator and in accordance with the label's requirements. Weed killer (herbicide) shall be an EPA registered herbicide, suitable for the purpose. Contractor shall submit data on the herbicide for approval: Contractor shall submit weed killer (herbicide) name, chemical composition, formulation, EPA registration and registered uses, concentration, application rate of active ingredients and method of application for the weed killer proposed for use in this project.Seed physical characteristics, % of mix for each seed, % germination for each seed, % weed seed, % inert material and recommendations. Fertilizer percentages of nitrogen, potassium, phosphorous and origin of organic nitrogen. Approval for type of seeding equipment. The Contractor shall only use a herbicide approved by the Contracting Officer.

If the Contractor proposes to use a herbicide that has been classified by the EPA for restricted use, the Contractor shall submit proof that supervisory personnel and personnel who work without supervision employed on this contract have current State of Colorado certification for the type of application to be used in this contract. The Contractor shall also show that he is in compliance with all licensing and registration procedures required by state law.

2.7 WATER

Source of water must be approved by Contracting Officer and of suitable quality for irrigation, containing no elements toxic to plant life.

2.8 EROSION CONTROL MATERIALS

Erosion control material must conform to the following:

2.8.1 Erosion Control Blanket

70 percent agricultural straw/30 percent coconut fiber matrix stitched with a degradable nettings, designed to degrade within 12 months.

2.8.2 Erosion Control Fabric

Fabric must be knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips must have a minimum life of 6 months.

2.8.3 Erosion Control Material Anchors

Erosion control anchors must be as recommended by the manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation prior to planting (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all

areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.1.1 Topsoil

Provide 4 inches of off-site topsoil or on-site topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer pH adjusters into soil a minimum depth of 4 inches by disking, harrowing, tilling. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.1.2 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Organic Granular Fertilizer 1 pounds per 1000 square feet.

3.2 SEEDING

3.2.1 Seed Application Seasons and Conditions

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy, frozen, snow covered or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.2.2 Pesticides

Pesticides shall not be applied within 3 weeks of grass seed germination.

3.2.3 Equipment Calibration

Immediately prior to the commencement of seeding operations, calibration tests shall be conducted on the equipment to be used. These tests shall confirm that the equipment is operating within the manufacturer's specifications and will meet the specified criteria. The equipment shall be calibrated a minimum of once every day during the operation for each individual seed mix before planting proceeds. The calibration test results shall be provided to the Contracting Officer's Representative within 1 week of testing. Equipment must be inspected prior to being brought on site in order to ensure equipment is clean and in good working condition.

3.2.4 Temporary Seeding

If permanent seeding cannot occur within 7 days of establishment of final grades, temporary cover crop shall be seeded to milo (Certified) at a rate of 8 PLS (Pure Live Seed) pounds per acre from mid-May to early June. Fall and winter temporary seeded species will be certified triticale (winter or spring variety as appropriate to time of year) at 15 PLS pounds per acre.

3.2.5 Seed Application Method and Equipment

Seeding method must be drill seeding.

3.2.5.1 Drill Seeding

Machinery for seeding must be cleaned prior to being brought on site and be free from all outside organic material. Seed must be drilled at the rates established in the Drawings. Drill seed uniformly to average depth of 1/4-inch to 1/2 inch. A range drill seeder with the following components will be required in natural areas where drill seeding operations are conducted:

a. Multiple seed boxes for different types of seed (agitators and picker wheels in at least one box).

b. Double disc furrow openers.

c. Intact depth bands with functioning scrapers on all disc openers to ensure consistent, uniform seed depth placement.

d. Seed tubes large enough to handle fluffy seed

e. Packer wheels with adjustable tension.

f. Coulter wheels.

Seeding will not be permitted when wind velocity is such as to prevent uniform seed distribution. No application shall be undertaken during inclement or the forecast of inclement weather.

3.2.6 Mulching

3.2.6.1 Hay or Straw Mulch

Hay or straw mulch must be spread uniformly at the rate of 2 tons per acre. Mulch must be spread by hand, blower-type mulch spreader, or other approved method. Mulching must be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch must not be bunched or clumped. Sunlight must not be completely excluded from penetrating to the ground surface. All areas installed with seed must be mulched on the same day as the seeding. Mulch must be anchored immediately following spreading.

3.2.7 Rolling

Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width.

3.2.8 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer.

3.2.9 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

3.4 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

3.5 PLANT ESTABLISHMENT PERIOD & GUARANTEE/WARRANTY

Warranty seeded areas for consistency and completion of coverage. Once a vigorously growing stand of vegetation is achieved, the request for Final Inspection may be made. A native vegetation stand is considered established when the vegetated area has at least 90% coverage with a maximum single bare spot of two square feet. See 32 05 33 LANDSCAPE ESTABLISHMENT for additional groundcover establishment requirements.

The planted areas shall be maintained and protected against damage until all work in the contract has been completed and accepted. If at any time prior to completion and acceptance of the contract work the planted areas are damaged by erosion, trespass, or other cause, the areas shall be repaired and replanted as originally specified at the Contractor's expense soil amendments shall be included in the contractor provided planting plan.

The seeding establishment period will commence on the date that inspection by the Contracting Officer shows that the seed mixes furnished under this contract have been satisfactorily installed and must continue for a period of 365 days. Written calendar time period shall be furnished for the seed establishment period. When there is more than one seed establishment period, the boundaries of the planted area covered for each period shall be described. The seed establishment period shall be modified for inclement weather shut down periods, or for separate completion dates for areas.

-- End of Section --

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SECTION 33 01 50.31

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02/20

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SECTION 33 01 50.31

LEAK DETECTION FOR FUELING SYSTEMS
02/20

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 77	(2024) Recommended Practice on Static Electricity
NFPA 407	(2022; TIA 21-1) Standard for Aircraft Fuel Servicing
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance

with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Leak Detection System; G, DO

Electronic Monitoring/Alarm Panel; G, DO

SD-03 Product Data

Leak Detection System; G, DO

Electronic Monitoring/Alarm Panel; G, DO

SD-06 Test Reports

Leak Detection System Test

SD-07 Certificates

Demonstrations

SD-08 Manufacturer's Instructions

Leak Detection System

SD-10 Operation and Maintenance Data

Leak Detection System; G, RO

Electronic Monitoring/Alarm Panel; G, RO

1.2.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.3 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship, and that have been in

satisfactory commercial or industrial use for a minimum 2 years prior to bid opening. Include applications of the equipment and materials under similar circumstances and of similar size. Materials and equipment must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

2.1.1 Nameplates

Attach nameplates to all specified equipment defined herein. List on each nameplate the manufacturer's name, address, contract number, acceptance date, component type or style, model or serial number, catalog number, capacity or size, and the system which is controlled. Construct plates of stainless steel . Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Provide nameplates with a minimum size of one by 2.5 inches. Provide normal block style lettering with a minimum 0.25 inch height. Accurately align all lettering on nameplates.

2.1.2 Metallic Requirements

Do not construct internal parts and components of equipment, piping, piping components, and valves that could be exposed to fuel during system operation of zinc coated (galvanized) metal. Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

2.2 ELECTRICAL WORK

Provide controllers, integral disconnects, contactors, controls, and control wiring with their respective pieces of equipment. Provide electrical equipment, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide switches and devices necessary for controlling and protecting electrical equipment. Provide controllers and contactors that have a maximum of 120-volt control circuits and that have auxiliary contacts for use with the controls provided.

2.2.1 Underground Wiring

Enclose underground electrical wiring in PVC coated conduit. Dielectrically isolate conduit at any steel storage tank connection.

2.2.2 Grounding and Bonding

Perform grounding and bonding in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.3 LEAK DETECTION SYSTEM

Provide a system, including sensors and detectors, that is intrinsically safe for use in a Class 1, Division 1, Group D environment as defined by NFPA 70. Provide system compatible with the fuel to be handled. Furnish sensors that distinguish and report the difference between hydrocarbons and water. Provide electronic output and transmission from sensors and detectors. Provide sensors that have a minimum probability of detection of 95 percent and a maximum probability of false alarm of 5 percent. Provide sensors and detectors that are compatible with the electronic

monitoring/alarm panel. Reuse sensors after an alarm condition is sensed. Submit shop drawings for the leak detection system that include the following.

a. Wiring schematics for all parts of the system showing each operating device and listing their normal ranges of operating values (including pressures, temperatures, voltages, currents, speeds, etc.).

b. Single line diagrams of the entire system, including any required alterations to the existing piping and tank(s).

c. Diagrams for posting that include distance markings such that alarm indications can be correlated to leak location in plan view. Include a piping and wiring display map with schematic diagrams from the leak detection system manufacturer. Frame diagrams under glass or laminated plastic and be posted where indicated by the Contracting Officer.

2.3.1 Underground Storage Tanks

Furnish system that continuously and automatically monitors the interstitial space of an underground tank for breaches in the integrity of the inner and/or outer tank shells. Monitor the interstitial space by using either an electronic capacitance type liquid sensor or a positive pressure system. Monitoring the interstitial space of a fiberglass reinforced plastic (FRP) tank may be performed using a liquid-filled interstitial space monitoring system. Freeze protect (brine) the liquid solution used in a liquid-filled interstitial and contain appropriate corrosion inhibitors. Detect and discriminate between high and low brine level conditions.

2.3.2 Underground Piping associated with tanks less than or equal to 50,000 gallons

Provide Leak Detection System associated with tanks less than or equal to 50,000 gallons that continuously and automatically monitors for piping leaks using an automatic line leak detector. Detect a minimum leak rate of 3 gallons per hour at 10 psig line pressure within 1 hour. Detect leaks against a minimum 6 feet of head pressure. Detect leaks from any portion of the underground product piping.

2.3.3 Containment Sumps

Provide Leak Detection System on sumps that continuously and automatically monitors each containment sump with an electronic capacitance type liquid sensor. Furnish sensor that detects liquids within a minimum of 1 inch above a sump's bottom. The leak detection system must be capable of triggering shutdown of the submersible turbine pump.

2.3.4 Monitoring Wells

Continuously and automatically monitor each monitoring well with a hydrocarbon/groundwater sensor. Hydrocarbon/groundwater sensor must distinguish the difference between hydrocarbons and water while totally immersed in groundwater. Sense when the groundwater level has reached a minimum definable setpoint. Provide vapor sensor to detect vapors of the fuel to be handled as well as sense the presence of liquid.

2.4 ELECTRONIC MONITORING/ALARM PANEL FOR PIPELINES ASSOCIATED WITH TANKS GREATER THAN 50,000 GALLONS

Perform continuous integrity checks on the status of each sensor's connections and wiring. Include a battery backup (rechargeable) that can operate the complete leak detection system during a power failure for a minimum period of 48 hours. Submit shop drawings of the panel layout along with panel mounting and support details. Provide panel that is compatible with and connected to the following:

a. Tank interstitial sensors and detectors.

b. Sump sensors and detectors.

c. Automatic line leak detectors.

d. Monitoring well sensors and detectors.

e. Digital tank gauge system as defined in Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.4.1 Panel Housing

Provide panel housing that is a NEMA 4 rated enclosure in accordance with NEMA 250 . Provide panel housing consisting of a hinged door to swing left or right (doors must not swing up or down).

2.4.2 Panel Alarms

Account for the effects of thermal expansion or contraction of the fuel product, vapor pockets, tank or piping deformation, evaporation or condensation, as well as groundwater levels (if applicable) prior to initiating an alarm condition. Panel must produce an audible and visual alarm in the event any of the following occur.

a. Sensing of a hydrocarbon liquid from a sensor or detector.

b. Sensing of a hydrocarbon vapor from a sensor or detector.

c. Sensing of water from a sensor or detector.

d. Failure of an automatic line leak test.

e. Loss of pressure in positively pressurized tank interstitial.

f. Sensing a high or low liquid level in liquid-filled tank interstitial.

g. Sensing minimum groundwater setpoint.

h. Failure of any integrity check.

i. Sensing tank high, high-high, or low level alarm conditions.

2.4.2.1 Audible Alarm

Panel must have external speakers that produce a buzzer sound of 70 decibels or greater in the event of a detected alarm condition. The audible alarm must be located in an area easily heard near the pumps in

the event of an alarm condition.

2.4.2.2 Visual Alarm

Provide a visual alarm that illuminates in the event of a detected alarm condition. Include either individual lights for each alarm condition or include a single light and a liquid crystal display (LCD) panel that displaces information regarding each alarm condition. The visual alarm must be located in an area where it can be seen near the pumps when illuminated in the event of an alarm condition.

2.4.3 Acknowledge Switch

Provide panel with a manual acknowledge switch that will deactivate the audible alarm. Do not deactivate subsequent audible alarms unless depressed manually again for each occurrence. Do not extinguish the visual alarms until the alarm condition has been corrected. Switches must be an integral component located on the front panel and be either a key switch or push button.

2.5 FINISHES

2.5.1 Factory Coating

Unless otherwise specified, provide equipment and components fabricated from ferrous metal with the manufacturer's standard factory finish. For equipment and component surfaces subject to temperatures above 120 degrees F, appropriately design the factory coating for the temperature service.

2.5.2 Field Painting

Field paint surfaces not otherwise specified as specified in Section 09 90 00 PAINTING, GENERAL. Do not paint stainless steel and aluminum surfaces. Do not coat equipment or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

PART 3 EXECUTION

3.1 INSTALLATION

Install parts requiring periodic inspection, operation, maintenance, and repair in locations that allow ready access. Install leak detection system and components in accordance with manufacturer's installation instructions.

3.1.1 Storage Tank Sensors/Detectors

Install interstitial tank sensors and detectors at the tank's low end. Install sensors in accordance with the tank manufacturer's recommendations and do not compromise the tank's secondary containment in any manner. Provide sensors that are easily removed from a tank. Connect metal conduit to steel tanks with dielectric fittings.

3.1.2 Automatic Line Leak Detector

Install detector on discharge side of each submersible pump in accordance with the pump and detector manufacturer's recommendations.

3.1.3 Sensors in Sumps

Install sensors in the low point of a sump in accordance with sump and sensor manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

3.2.1 Leak Detection System Test

Activate and test the entire leak detection system in accordance with manufacturer's testing procedures. Use the electronic monitoring/alarm panel to record and present the results.

3.2.2 Storage Tank Tightness Tests

For tanks less than or equal to 50,000 gallons, storage tank tightness tests must be performed in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. Use the electronic monitoring/alarm panel to record and present the results.

For tanks greater than 50,000 gallons, storage tank tightness test must be performed with a system that is certified to be able to detect leaks at no more than 0.5 gallons per hour.

3.2.3 Tank Fill Tests

Perform high liquid level alarm tests on storage tanks in accordance with Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS. Use the electronic monitoring/alarm panel to record and present the results.

3.3 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the equipment/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/equipment/systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of 2 hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training.

-- End of Section --

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SECTION 33 05 23

TRENCHLESS UTILITY INSTALLATION
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PART 1 GENERAL

Provide utility installation using boring and jacking techniques at locations indicated. The Contractor is responsible for all work related to the provision of utilities installed, including assessing surface, subsurface, and environmental (seasonal) conditions.

1.1 Scope of Work

Alignment 1. Provide a 12-inch steel casing pipe. Length is 119.28 feet long for FL-1. See Sheet MS201 for profile. The casing pipe shall provide a casing for an 8.6-inch double walled fuel line. Provide cementitious grout between the 12-inch steel casing pipe and the 8.6-inch doubled wall fuel line.

Alignment 2. Provide a 12-inch steel casing pipe. Length is 119.27 feet long for FL-2. See Sheet MS202 for Profile. The casing pipe shall provide a casing for an 8.6-inch double walled fuel line. Provide cementitious grout between the 12-inch steel casing pipe and the 8.6 inch doubled wall fuel line.

Alignment 3. Provide a minimum of a14-inch steel casing pipe for a minimum of a 4-inch HDPE comm casing. Length is approx. 120 feet. See MS201 and MS202 for rough alignment profiles. See Section A15 on Sheet ES502 for cross section. Fill the space between the 14-inch steel casing and the 4-inch comm conduit and spare with cementitious grout. Provide HDPE spacers.

Alignment 4. Provide a minimum of a14-inch steel casing pipe for a minimum of a 4-inch HDPE ES Conduit and spare. The length is 40 ft long. Minimum depth of installation is 6 feet under road. See Section A15 on Sheet ES502 for cross section. The 14-inch steel casing pipe shall provide a conduit for a 4-inch ES line and spare. Fill the space between the 14-inch steel casing and the 4-inch ES conduit with cementitious grout. Provide HDPE spacers.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2023) Manual for Railway Engineering

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 27-00	(2000) Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction

ASCE 28-00	(2001) Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.5M/D1.5	(2020; Errata 1 2022) Bridge Welding Code

ASTM INTERNATIONAL (ASTM)

ASTM A139/A139M	(2022) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM C33/C33M	(2023) Standard Specification for Concrete Aggregates
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C1091	(2003a; R 2013) Standard Test Method for Hydrostatic Infiltration Testing of Vitrified Clay Pipe Lines

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2024) Safety -- Safety and Occupational Health (SOH) Requirements

1.3 DEFINITIONS

As used herein, the terms "shaft" and "pit" are synonymous.

1.3.1 Jacking Precast Concrete Pipe

Unless otherwise specified or indicated, see ASCE 27-00 for definitions.

1.3.2 Jacking Precast Concrete Box Sections

Unless otherwise specified or indicated, see ASCE 28-00 for definitions.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section

01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Boring and Jacking Plan; G, RO

Statement of Contractor Qualifications

SD-03 Product Data

Pipe casing and couplings; G, DO

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.

SD-05 Design Data

Design calculations for pipe casing; G, DO,

Access Shaft Construction Plan; G, DO

SD-06 Test Reports

Monitoring Survey; G, RO

SD-08 Manufacturer's Instructions

Installation procedures for pipe casing; G, RO

Safety Data Sheets; G, RO

SD-11 Closeout Submittals

Record Drawings; G, RO

Daily Work Logs of installation operations, including records of the volume of materials removed, daily progress and grout volumes used, and as-built drawings of location and alignment of casing pipeline; G, RO

1.5 PRE-CONSTRUCTION

No later than 45 days prior to commencement of the work, submit the following to the Contracting Officer for review and approval:

Boring and Jacking Plan

Access Shaft Construction Plan

Statement of Contractor Qualifications

Submit a complete list of all drilling fluids, additives, and mixtures to be used along with Safety Data Sheets.

1.6 QUALITY CONTROL

1.6.1 STATEMENT OF CONTRACTOR QUALIFICATIONS

Contractors are required to have proven and successful experience in . boring and jacking. The experience is the successful completion of similar projects to the tolerances indicated for the size of pipe and quantities shown on the plans, in the anticipated soil conditions indicated in the geotechnical report included in the contract documents. Submit a description of at least three such projects which include, at a minimum, a listing of the location(s), date of projects, owner with contact information, pipe type, size installed, length of installation, type, and manufacturer of equipment used, and other information relevant to the successful completion of the project.

1.6.2 RECORDS

1.6.2.1 DAILY WORK LOG

Maintain a work log of construction events and observations. Include the following information for each days work:

a. Hours worked.

b. Location of boring machine face or shield by station and progress made in advancing pipe.

c. Completed field forms, such as steering control logs, for checking line and grade of boring operation, showing achieved alignment relative to design alignment.

d. Maximum pipe jacking pressures per drive.

e. Ground water control operations and piezometric levels.

f. Descriptions of soil conditions encountered.

g. Any unusual conditions or events, including observed ground movement.

h. Reasons for operational shutdown in event drive is halted.

1.7 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes free of dirt and debris.

1.7.1 Handling

Handle pipe in a manner to ensure delivery to the excavation site in sound undamaged condition. Avoid damage to coatings and linings on pipe; make repairs if coatings or linings are damaged. Carry, do not drag pipe to the excavation site. Store jointing materials and rubber gaskets that are not to be installed immediately, under cover out of direct sunlight. Handle steel pipe with coating in accordance with the provisions for handling coal-tar enamel coated pipe in AWWA C203. Handling coal-tar epoxy coated steel is not permitted below 40 degrees F.

1.8 SAFETY

1.8.1 General

Provide procedures for safe conduct of the work in accordance with EM 385-1-1. When and where installations temporarily disrupt pedestrian use of sidewalk areas for periods exceeding 2 consecutive work days, provide an alternate route that meets current ABA Accessibility Standard for Department of Defense Facilities.

1.8.2 Equipment

Utilize equipment that employs a common grounding system to prevent electrical shock in the event of underground electrical cable strike. Ensure the grounding system connects all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operators booth, worker grounding mats, and any other interconnected equipment to a common ground. Utilize equipment having an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.

1.8.3 Sheeting, Shoring and Dewatering

Provide sheeting, shoring and dewatering as specified in Section 31 00 00 EARTHWORK, and as specified herein.

1.8.4 Tunnel Bore

Unprotected mining of the tunnel bore is not permitted. Fully support the tunnel face and bore at all times.

1.9 QUALITY ASSURANCE

1.9.1 Boring and Jacking Plan

Provide a plan prepared, signed and sealed by a licensed Professional Engineer and include the following:

1.9.1.1 Operational Layout

1.9.1.1.1 Layout Plan

Provide a plan location of the operation, discussing relationship of equipment, the method of construction and details for the following:

a. Access pits configurations and details, including equipment layout.

b. Location of intermediate jacking stations, if required.

c. Casing pipe with connection details.

1.9.1.1.2 Pedestrian Access Around Site

When and where installations disrupt pedestrian use of sidewalk areas for periods exceeding 2 consecutive days, provide an alternate route that meets current ADA requirements.

1.9.1.2 Method and Procedures

Provide an outline of the methods and procedures, including drawings, schedule of operations, specifications, and manufacturer's catalog data for products in lieu of specifications, methods of operation for boring and jacking operations, and specifically the following:

a. Jacking Equipment and Methods: Provide drawings of the jacking frame, jacking head, reaction blocks, jacking installation, pipe guides, procedures for lubricating exterior of pipe during jacking (if applicable), maximum force that jacking equipment can deliver.

b. Boring Equipment and Methods: Provide a discussion of the methods of operation, design and specifications for boring operation, steerage control, line and grade control methods, proposed procedures for removing or clearing obstructions, and a description of proposed methods for ground stabilization and minimizing overexcavation and loss of ground. Submit safety data sheets for fluids, grout, or chemical products.

c. Casing Annulus and Interior Space Grouting: Identify casing insulators/spacers/centralizers/tiedowns (type, number, spacing and installation instructions,) grout materials and method of placement, description of equipment used and grout pressure employed.

d. Survey Alignment Control: Identify method and equipment to install pipe within specified tolerances.

e. Ground Stabilization: Discuss dewatering and grouting, identification of measures and methods used to stabilize face at heading (if necessary), narrative of equipment, procedure and grout mix, and identification of subcontractor who will perform any required stabilization grouting.

f. Excavation Support System Plan: Provide a plan and discussion of methods to be employed, including design drawings and calculations, sealed and signed by a licensed Professional Engineer.

g. Monitoring/Survey Plan: Develop and provide a discussion of the monitoring/survey plan to be employed to protect structures and utilities from settlement and/or heave, including the following. Incorporate into the plan any supplemental requirements specified in Part 3, paragraph entitled "Field Quality Control".

(1) Structures Assessment: Provide a discussion of structures and utilities to be protected, and measures to be employed for preconstruction and postconstruction assessment of critical structures, namely those located within the zone of active excavationa distance equal to times the depth of the boring from the ground surface from proposed pipe centerline. Include photographs or video of existing damage to structures in the vicinity of sewer alignment in assessment reports.

(2) Instrumentation Monitoring Plan: Describe of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

(3) Surface Settlement Monitoring Plan: Identify on a plan the

location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.

h. Contingency Plan: Provide a plan and discuss protection of pavements, adjacent structures, and utilities affected by adverse movements detected by instrumentation. As a minimum, include the following:

(1) Names, telephone numbers, and locations of persons responsible for implementation of contingency plans.

(2) Materials and equipment required to implement contingency plans. Identify the location of all required materials and equipment.

(3) Step-by-step procedure for performing work involved in implementation of the contingency plans.

(4) Clear identification of the objectives of the contingency plans and methods to measure plan success.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The work includes providing labor, materials, and specialized equipment for the installation of utility pipelines utilizing the boring and jacking methods of installation.

2.1.1 Design Requirements

2.1.1.1 Excavations

Design excavations, including access shaft walls, considering loadings from reaction blocks, traffic loads and any surcharge loads.

2.1.1.1.1 Highway Crossing Criteria

For loadings under highways use HS20 vehicle loading distribution in accordance with AASHTO.

2.1.1.1.2 Railway Crossing Criteria

For pipe crossings under railways use Cooper E-80 locomotive loading distributions in accordance with AREMA Eng Man specifications for culverts. Account for loading due to any multiple tracks.

2.1.1.2 Design Calculations of Pipe Casing

Submit design calculations for pipe casing demonstrating that the equipment used in installing the pipe will not distort or otherwise damage the pipe. Provide calculations of maximum allowable jacking force to be used based on pipe materials to be used. The calculations are to be sealed by a licensed Professional Engineer using soil properties derived from subsurface investigations performed along the utility route.

2.2 EQUIPMENT

2.2.1 Boring and Jacking System

Utilize a continuously monitored boring and jacking system matched to the expected subsurface conditions, a hydraulic jacking system to jack the pipeline, an auger to remove boring spoils, a guidance system to provide installation accuracy within the indicated tolerances, excavation equipment, material handling equipment, a dewatering system, and sheeting/shoring required to provide the work indicated.

2.2.2 Pipe Jacking Equipment

Provide main jacking equipment with a capacity greater than the anticipated jacking load. Provide intermediate jacking stations when the total anticipated jacking force needed to complete the installation may exceed the capacity of the main jacks or the designed maximum jacking force for the pipe. The jacking system is to supply a uniform distribution of jacking forces on the end of the pipe by use of thruster rings and cushioning material.

2.3 MATERIALS

2.3.1 Pipe Casing

Provide straight wall pipe casing of type and diameter indicated of . steel pipe.

2.3.1.1 Steel Pipe

2.3.1.1.1 Pipe

Provide steel pipe in conformance with ASTM A139/A139M, Grade B with a minimum yield strength of 35,000 psi. Weld steel pipe seamless, square cut with even lengths that complies with Articles 4.2, 4.3, and 4.4 of the .. Pipe shall have an inside diameter of 12 inches and a minimum wall thickness of 0.5 inches, for alignment 1 and 2.

2.3.1.1.2 Joints

Utilize casing pipe having beveled ends with a single V-groove for field welding. Butt weld joints using a full-penetration weld on the outside circumference of the pipe prior to jacking. The welds are to conform to the latest AWS Welding Code by a certified welder. Unless otherwise specified, inspect and test welds .visual inspection criteria by a certified welder and by the QC manager welds on casing pipe that is sacrificial (fully grouted internally). Non-destructive testing is not required on welds on casing pipe that is sacrificial.

2.3.1.1.3 Roundness

The maximum difference between the major and minor outside diameters cannot exceed one percent of the specified nominal outside diameter or 0.25 inch, whichever is less.

2.3.1.1.4 Circumference

Ensure that the outside circumference is within plus one percent of the nominal circumference or within plus 0.50 inches, whichever is less.

2.3.1.1.5 Straightness

The maximum allowable straightness deviation in any 10 foot length cannot exceed 1/8 inch. For lengths over 10 feet, the maximum allowable deviation of the entire pipe length is computed by the following formula, but not to exceed 3/8 inch in any length exceeding 30 foot length: Maximum Allowable Deviation in inches equals (1/8) times (total length in feet) divided by 10.

2.3.1.1.6 Pipe Ends

Ensure that the end of the pipe is perpendicular to the longitudinal axis of the pipe and within 1/16 inch per foot of diameter, with a maximum allowable deviation of 1/4 inch measured with a square and straightedge across the end of the pipe.

2.3.2 Grout

Provide cement grout for pressure grouting to fill the voids around the casing and for filling the interior annular space between carrier pipe and the casing composed of Portland cement conforming to ASTM C150/C150M, Type II, and sand meeting requirements of ASTM C33/C33Mfor fine aggregate, sufficiently fluid to inject through the casing and fill voids, with prompt setting to control grout flow. Utilize a grout with a minimum compressive strength of 100 psi attained within 24 hours. Admixtures are to be free of chlorides, corrosive or other material detrimental to the materials the grout contacts.

2.3.3 CONCRETE

Provide 3000 psi concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.3.4 SOIL MATERIALS

Provide soil materials in accordance with the requirements specified in Section 31 00 00 EARTHWORK.

2.4 Incidental Materials

2.4.1 Casing Insulators/Bore Spacers

Provide carbon steel with polyvinyl chloride coating or stainless steel casing insulators/bore spacers and HDPE spacers 8 inches in length for pipe 12 inches and less in diameter, and 12 inches in length for pipe 14 inches and greater in diameter, having a 2 inch minimum runner width. Orient spacers to allow for grout to flow easily to completely fill the casing pipe with grout throughout its length.

2.4.2 End Closures/Bulkheads

Provide Temporary End Closures to contain grout used for filling the annular space between conduits and the casing. Provide Permanent End Closures of 1/2 feet length as indicated consisting of brick and mortar (one part cement/two parts sand/water) to completely encapsulate the conduits transition into the casing. Center the closure on the casing pipe end.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Access Shaft and Pit Construction Plan

No later than 45 days prior to start of construction submit an Access Shaft Construction Plan. Include in the plan a discussion of the method of construction of access shafts used for boring and jacking. Address the excavation methods, dewatering system, sheeting/shoring and bracing systems proposed for use, and any ground stabilization to be employed for the shaft work area or thrust block. Acceptable construction methods include the use of interlocked steel sheetpiling or precast circular concrete segments lowered in place during excavation.

3.1.1.1 Design Requirements

a. Construct shafts of a size commensurate with safe working practices at locations indicated. Coordinate shaft locations with the Contracting Officer. The Contractor may propose to relocate shafts to better suit the capabilities of the equipment/methods proposed, but may not alter either the indicated pipeline alignment or structures associated with the installed pipeline, nor result in additional claims for compensation.

b. To the extent possible, keep shaft locations clear of pavements , in order to minimize disruption to the flow of traffic. Locate support equipment, spoil piles, and materials to minimize disruption to traffic.

c. Support all excavations and prevent movement of the soil, pavement, utilities or structures outside of the excavation. Furnish, place, and maintain sheeting, bracing, and lining required to support the sides of all shafts and to provide adequate protection of the work, personnel, and the general public. Provide a concrete floor in the jacking access shaft. Design loads on the sides of the jacking and receiving pit walls are dependent on the construction method and flexibility of the wall systems.

d. Consider the loading from boring or pipe jacking when preparing the design of the jacking and receiving pit supports as well as special provisions and reinforcement around the breakout location. Design the base of the pits to withstand uplift forces from the full design head of water, unless approved dewatering or other ground modification methods are employed.

e. Construct a thrust block to transfer jacking loads into the soil. Ensure that the backstop and the proposed pipe alignment are square to each other and are designed to withstand the maximum jacking pressure to be used with a factor of safety of at least 2.5. Also, design the thrust block to minimize excessive deflections in such a manner as to avoid disturbance of adjacent structures or utilities or excessive ground movement. Begin jacking operations only after concrete thrust block or treated soil has attained the required strength.

f. If tremie concrete sealing slabs are placed within the earth support system to prevent groundwater inflow when access shafts are dewatered, furnish and install sealing slabs of sufficient thickness to provide a minimum factor of safety of 1.2 against hydrostatic uplift in order to

prevent bottom blowout when the excavation is completely dewatered.

3.2 CONSTRUCTION

3.2.1 Access Shafts

3.2.1.1 Construction Requirements

a. Provide ground stabilization in the work area and the thrust block as required to accomplish the work.

b. Construct a jacking access shaft to accommodate the installation of pipe casings, equipment and piping jacking device. Install thrust blocks(s) as required and consolidate the ground (grout) where the casings exit the shaft. Provide a dry jacking work area having a stable concrete floor that drains to a recessed sump pump to handle nuisance inflow. Groundwater inflows into the jacking shaft are not to exceed 5 gallons/minute; soil inflows are not to exceed a total volume of 2 cubic feet.

c. Construct a receiver shaft to accommodate the installation of pipe casings and the equipment used in the work. Consolidate the ground (grout) where the casings enter the shaft.

d. Furnish, install, and maintain equipment to keep the jacking shaft free of excess water. Provide surface protection during the period of construction to ensure that surface runoff does not enter shafts. Adhere to the dewatering plan and do not affect surrounding soils or structures beyond the tolerances stated in paragraph entitled "Tolerances."

e. Provide security fence around all access shaft areas and provide shaft cover(s) when the shaft area is not in use.

f. Pit Backfill and Compaction: Upon completion of the pipe jacking and all tests or inspections are complete remove all equipment, debris, and unacceptable materials from the pits and commence backfilling operation. Complete backfilling, compaction, and pavement repairs in accordance with Section 31 00 00 EARTHWORK.

3.3 INSTALLATION

3.3.1 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe in accordance with the American Public Works Association Uniform Color Code. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.

3.3.2 Connections to Existing Lines

Schedule connections to existing lines with the Contracting Officer to cause a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped as indicated.

3.3.3 Advancing the Pipe

Jack each pipe casing section forward as the excavation progresses in such a way to provide complete and adequate, ground support at all times. Utilize a bentonite slurry applied to the external surface of the pipe to reduce skin friction. Provide a jacking frame for developing a uniform distribution of jacking forces around the periphery of the pipe. Place a plywood spacer on the outer shoulder of the pipe casing joint. Design and construct the thrust reaction backstop to withstand the jacking forces. Continuously maintain a square alignment between the backstop and pipe casing and support the maximum obtainable jacking pressure with a safety factor at least 2.0. Continuously monitor the jacking pressure and rate of cutter head advancement. Exercise special care when setting the pipe guard rails in the jacking pit to ensure correctness of the alignment, grade and stability.

3.3.3.1 Installation Requirements

a. Utilize boring equipment capable of fully supporting the face of the tunnel.

b. Maintain face pressure exerted at the heading by the MTBM as required to prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface by balancing soils and groundwater pressures present.

c. Dewatering for groundwater control is allowed at the jacking and receiving pits only.

d. Do not jack pipe casing until the concrete thrust block and tremie seal (if selected), and grouted soil zone in jacking and receiving shafts have attained the required strength.

e. Jack the pipe into place without causing damage to the coatings, joints or completed pipe section.

f. After completion of the jacking operation between jacking and receiving shafts, displace the lubricate material from between the pipe casing exterior and the surrounding ground with a cement grout. Control pressure and the amount of grout to avoid pipe damage and displacement of the pipe and soil beyond the tolerances specified in paragraph "Tolerances." Grout within 48 hours after pipe installation has been completed to prevent any surface settlement due to movement of soil material into the void space or loosened zone around the pipe casing.

g. Replace pipe casings damaged during installation.

h. Ensure that the welds of steel pipe attain the full strength of the pipe and are watertight before jacking of the pipe section. Ensure that the inner face of the internal weld seam is flush with the pipe to facilitate the installation of the carrier pipe in the pipe casing.

i. Perform all welding in accordance with requirements for shielded metal arc welding of AWS D1.5M/D1.5 for bridges and AWS D1.1/D1.1M for buildings and other structures.

j. Provide a pipeline that has a consistent diameter across assembled joints.

k. Once the tunneling process has begun, continue with that process uninterrupted until the pipe reaches the receiving shaft. Continue to push any damaged pipe until that damaged pipe section is pushed into the receiving shaft and is removed. Notify the Contracting Officer immediately if any pipe is known to be or believed to be damaged.

3.3.4 Carrier Pipe Installation

3.3.4.1 Cleaning

Clean the inside of the casing of all foreign matter by using a pipe cleaning plug.

3.3.4.2 Carrier Pipe Joints

Inspect with the Contracting Officer, prior to backfilling trenches, the transition of carrier pipe within the casing to non-cased trenching.

3.3.4.3 Casing Insulators/Spacers

Install casing insulators/spacers in accordance with approved submittals and the drawings. On center spacing is not to exceed 4 feet.

3.3.4.4 End Closures/Bulkheads and Grouting of Casing Pipe

a. Closures: Seal ends of casing with cementatious grout.

b. After installing, inspecting and acceptance of the carrier pipe and spacers within the casing pipe, pressure fill the annular space between the carrier pipe and the casing pipe, with cement grout specified herein. Regulate pump pressures to refusal or in accordance with the approved grouting plan. Place grout in a sequence and manner that will preclude voids or pockets of entrapped air or water. Use a refusal pressure equal to 0.5 psf per foot of overburden.

3.3.5 Ventilation

Provide adequate ventilation for all tunnels and shafts, following confined space entry procedures. Include such factors as the volume required to furnish fresh air in the shafts, and the volume to remove dust that may be caused by the cutting of the face and other operations which may impact the laser guidance system. Routinely test the air in areas accessed by workers in accordance with the most current OSHA methods and standards. The current OSHA allowable gas concentrations or those presented below, whichever are more stringent, shall be met:

Carbon Monoxide	$\leq$0.005 percent
Methane	$\leq$0.25 percent
Hydrogen Sulfide	$\leq$0.001 percent
Oxygen	$\geq$20.0 percent

3.3.6 Lighting

Provide adequate lighting for the nature of the activity being conducted

by workers. Separate and insulate with ground fault interrupters power and lighting circuits. Comply with requirements with regards to shatter resistance and illumination requirements.

3.3.7 Spoil Transportation

Match the excavation rate with rate of spoil removal. Utilize a system capable of balancing groundwater pressures and adjustment to maintain face stability for the particular soil conditions of the project.

3.4 TOLERANCES

3.4.1 Tolerances

Maximum allowable lateral deviation is 1 percent of length; maximum allowable vertical deviation is 1 percent of lenght in the position of every completed 300 foot section of jacked pipe casings. Fuel must be free draining between any two points at the pipe invert. Reverse grades are not permitted.

3.5 FIELD QUALITY CONTROL

Employ the monitoring/survey plan. Maintain daily records in accordance with the paragraph titled RECORDS.

3.5.1 Instrumentation/Survey

3.5.1.1 Mandatory Requirements

Include the following, as a minimum, to supplement Contractor Quality Control measures employed to monitor ground surface heave or settlement in the monitoring/survey plan.

a. Monitor ground movements associated with the project using established survey points and make changes in the construction methods that control ground movements and prevent damage or detrimental movement to the work and adjacent structures and pavements.

b. Record in the daily work log a summary of monitoring survey results. Clearly identify work not meeting specified requirements, out-of-tolerance results, and impacts on new or existing work from settlement or heave.

c. Install instrumentation and perform monitoring to determine ground settlement surrounding each jacking and receiving pit.

d. Prior to any excavation activities, perform a pre-construction survey of the areas in and surrounding excavations and along the proposed utility alignment to identify any structures, facilities, underground or above ground utilities to be protected within a radius of five times either the depth of any excavation or the depth of trenchless excavation.

3.5.1.2 Supplemental Requirements

a. Prior to the start of advancing the pipe or any dewatering operation, install surface settlement markers along the trenchless excavation centerline using the following guidelines:

(1) Locate surface settlement markers in a grid, spaced 10 feet by 10 feet extending not less than 30 feet on either side of the trenchless excavation centerline. Use wooden hubs in unpaved areas with the hubs driven flush with the surface and a tack driven in the top for level rod placement. Use temporary paint or other approved materials in pavement areas. Minimize the size of temporary markings to the greatest extent practical. Remove all markers and markings prior to completion of work.

b. Prior to the start of advancing the pipe or dewatering operations, survey all monitoring points a minimum of three times to establish baseline readings. Perform all surveys to an accuracy of 0.01 foot. Survey daily every 12 feet of casing pipe advancement. In addition, if settlement exceeds Limit Level 2 survey all monitoring points within 20 feet of the heading hourly when the heading is approaching or passing beneath the monitoring points.

c. Evaluate all monitoring survey data immediately to determine corrective or mitigation action should be taken using the following evaluation criteria:

TYPE OF MONITORING POINT	LIMIT LEVEL 1	LIMIT LEVEL 2
Surface - Unpaved	+/- 1/4 inch	+/- 3/4 inch
Surface - Paved	+/- 1/4 inch	+/- 1/2 inch

d. If the survey readings indicate settlement or heave is greater than Limit Level 1 in the above table, provide notification to the Contracting Officer immediately and increase the monitoring frequency of the instruments as directed. Proceed with advancing the pipe after providing mitigating measures to limit additional movements.

e. If the survey readings indicate settlement or heave is greater than Limit Level 2 in the above table, cease work and provide notification to the Contracting Officer immediately and implement the Contingency Plan.

f. Perform all repairs and/or rebuilding of the pavement or adjacent structures to their condition existing prior to settlement/lifting.

g. Continue to monitor by the survey at 2 week intervals for a period of 6 weeks after tunneling. When the survey identifies that heave or settlement has occurred that is greater than Limit Level 2 values, make repairs to new or existing work that is affected. Discontinue topographic surveys when settlement is no longer detected.

3.5.2 Field Tests

Perform field tests, and provide labor, equipment, and incidentals required for testing , except that water and electric power needed for field tests will be furnished as set forth in Section. Submit test results, identifying any results that do not meet specified requirements, to the Contracting Officer within 4 days of test completion. Provide corrective action and retest pipe not meeting specified requirements.

Provide corrective action as recommended by the pipe manufacturer and subject to approval by the Contracting Officer.

3.5.2.1 Pipe Casing

Inspect and verify that pipe material meets the dimensional tolerances specified prior to use. Record each days inspection results in the daily work log.

3.5.2.1.1 Testing Requirements for Gravity Mains

Perform low pressure air test of all gravity mains (structure to structure) in accordance with ASTM C1091 Standard Test method for Hydrostatic Infiltration testing of Vitrified Clay Pipe Lines.

3.5.2.1.2 Non-Standard Pipe Lengths

Cut non-standard joint lengths from full length pipe having satisfactorily passed the hydrostatic test.

3.5.2.1.3 Elevations

Prior to removal of MTBM equipment, sheeting, and backfilling of access shafts, collect invert information on pipeline installed. Confirm that the elevations meet stated tolerances.

3.6 CLEANUP AND FINAL CLOSEOUT

3.6.1 Site Cleanup

Immediately clean "blow holes" or "breakouts" of drilling fluid to the surface and fill depressions with satisfactory fill material. Dispose of all drilling fluids, soils, and separated materials in compliance with Federal, State, and local environmental regulations.

3.6.2 Drilling Fluid

Immediately upon completion of work of this section, remove all rubbish and debris from the job site. Remove all construction equipment and materials leaving the entire area involved in a neat condition equal to existing conditions prior to construction, unless indicated otherwise.

3.6.3 Record Drawings and Daily Work Logs

Submit an electronic copy and three hard copies of the record drawings to the Contracting Officer within 5 days after completing the work. Include in the record drawings a plan, profile, and all information recorded during the progress of the work. Clearly tie the record drawings to the project's survey control. Maintain and submit upon completion final Daily Work Logs of installation operations, signed by the superintendent.

3.7 DISPOSITION OF MATERIAL

Dispose of waste in Government offsite miles. Remove from Government property surplus or other soil material not required or suitable for fill or backfilling.

Store or legally dispose of excavated material and fluids used in the boring process and shaft construction away from the construction site and

in compliance with all permits and applicable Federal, State, and local regulations. Only store or stockpile materials in areas shown on Contract drawings. Stockpiling is permitted on the construction site provided material is removed at regular intervals not exceeding 48 hours.

-- End of Section --

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SECTION 33 08 55

FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT)
08/19

PART 1 GENERAL

1.1 SUMMARY/APPLICABILITY

This specification defines the requirements and procedures for startup and performance testing of all equipment, components, control systems, devices, and associated appurtenances which are used for the receipt, storage, transfer and issue of petroleum fuel products for non-hydrant fuel facility systems. It covers requirements for safety, Government scheduling and coordination, device testing, existing and new system cleanliness, system flushing, demonstration of indicated and specified system performance, and final acceptance and reporting. The types of fuel systems covered include:

a. tank truck, rail car, pipeline and marine off-loading and loading systems

b. fuel transfer pumphouses and systems

c. installation pipelines and interterminal pipelines

d. military service station facilities handling gasoline, diesel, and jet fuel that:

(1) refuel (provide motive fuel for) commercial type government vehicles.

(2) refuel (provide motive fuel for) military tactical vehicles.

(3) load fuel into the storage tanks of tactical refueler tank trucks.

It does not cover private vehicle fueling stations such as exchange service stations, nor aircraft direct refueling hydrant systems.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 1595	(2012; R 2019; 2nd Ed) Design, Construction, Operation, Maintenance, and Inspection of Aviation Pre-Airfield Storage Terminals

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 1110-1-8167	(2016) Engineering and Desig -- Petroleum, Oil, and Lubricants Mandatory Center Of Expertise

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Plans

The Contractor must submit detailed written plans (prepared by the System Supplier) for implementation of the System Start-Up Plan, the Fuel Provisioning Plan, and the Performance Testing Plan. The plans must specify a detailed plan incorporating in a sequential manner all work specified in PART 3 EXECUTION of this specification section. Plan elements must include:

a. Personnel. List of Contractor's personnel by trade, list of key personnel, list of safety equipment, list of miscellaneous equipment such as two-way radios, and personnel transportation vehicles.

b. Fluid Used for Hydrotesting, and Flushing. Identify what fluid will be used for each operation in each system section.

c. Fuel. See the Fuel Provisioning Plan.

d. Storage-Into. Identify where the contents of the piping will be pushed into including the capacity required, how the storage vessel will be prepared for receiving the piping content, how it will be emptied and how it will be cleaned after the contents are removed.

e. Storage-From. Identify where the fluid that will be drained or pushed into the piping will come from including the capacity required, the number, size and type of the storage vessel, how the storage vessel is filled, how it will be emptied, and how it will be cleaned after the contents are removed.

f. Piping. Notwithstanding the requirements described elsewhere, every pipe section and individual component in the system covered by this specification section must be filled, vented, hydrostatically tested, flushed, cleaned, and tested for fuel quality. It must also be able to be isolated and drained if found that it needs repair. The Plans must detail how this is to be done.

g. Equipment Tests. Detailed procedures and schedules for each system component to perform all system tests under each operating scenario in accordance with paragraph EQUIPMENT TESTS.

h. Performance Testing. Detailed procedures and schedules for each system component to perform all system tests under each operating scenario in accordance with paragraph PERFORMANCE TESTING.

i. Hydrotesting Plans. See the Work Plan in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

j. Schedule. Schedules must be generated with listing dates and durations of all system start-up activities as well as regular coordination and safety meetings and dates of key events for Government participation.

k. Contingency plans. Information on spill and fire contingencies, along with the required Government Fire and Safety Office involvement and approvals.

l. Coordination with Installation. Description of how Contractor and System Supplier must implement system start-up in coordination with ongoing operations at the Installation. Plan must incorporate all phasing and work restriction requirements of the Contract documents.

1.3.2 Copies of API Publication

Provide four copies of API RP 1595 to the Contracting Officer.

1.3.3 Fuel Testing Laboratory Qualifications

Contractor must submit the qualifications of the DoD Fuel Testing Laboratory which will be used to test the fuel samples.

1.3.4 System Start-up Plan

Submit a detailed written plan prepared by the Contractor and System Supplier for implementation of System Start-Up. Submit the plan 60 (CONUS) days prior to System Start-Up. The Contractor and System Supplier are responsible for implementing System Start-Up in coordination with ongoing operations.

1.3.5 Performance Testing Plan

Submit a detailed written plan prepared by the Contractor for implementation of Performance Testing. Submit the plan 60 (CONUS) days prior to System Start-Up. The Contractor and the System Supplier are responsible for implementing the Performance Testing Plan in coordination with ongoing operations.

1.3.6 Fuel Provisioning Plan

Submit a detailed written Fuel Provisioning Plan prepared by the Contractor. The Fuel Provisioning Plan must include a timeline for the required receipt date(s), grade of fuel, and quantity of fuel on each receipt date required to execute the Start-up and the Performance Testing plans.

1.3.7 Certification (Ready for Start-Up and Performance Testing)

As a prerequisite to fuel system start-up, the Contractor must submit a certificate that certifies all work provided on the fuel system, except for touch-up field painting, has been inspected and approved by the specified approving authorities. Further, the Contractor must certify on this certificate that all specified checks and inspections have been successfully completed prior to start-up. Submit the plan 30 (CONUS) notice prior to commencement of fuel system start-up. The Contractor must submit the Certificate of Completion to the Contracting Officer at least 7 calendar days prior to commencement of system start-up and performance testing. The Contracting Officer must then be responsible for scheduling the Government representatives and appropriate military command authority for participation in the inspection, performance testing, and final approval activities. Any contractual deficiencies observed must be corrected by the Contractor without cost to the Government.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for

Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Copies of API RP 1595; G, DO

System Start-Up Plan; G, DO

Performance Testing Plan; G, DO

Fuel Provisioning Plan; G, RO

SD-06 Test Reports

Final Reports; G, DO

Equipment Tests; G, DO

Piping Flushing Checklist; G, DO

SD-07 Certificates

Fuel Testing Laboratory Qualifications; G, RO

Certification (Ready for Start-Up and Performance Testing); G, DO

Contractor Start-Up Qualifications; G, RO

Certificate of Calibration; G, RO

Disposal Of Waste Materials

SD-11 Closeout Submittals

Certification of Entire System

1.5 CLOSEOUT SUBMITTALS

1.5.1 Final Reports

Contractor must prepare a final report that documents the execution of the approved start-up and performance testing plan. All items of work specified in the Start-up and Performance Testing plans must be carried out and reported in this report unless otherwise approved by the Contracting Officer. Include as a part of this report:

a. Verification letters of approved fuel storage tank hydrostatic tests and the approved piping hydrostatic tests, as generated under other specification sections.

b. Final settings of the valves and switches.

c. A copy of the flow and pressure output graphs and excel data and charts on CDR media with an explanation of what the graph indicates and what the system is doing.

d. A schematic flow diagram drawing of the resultant system showing major valves with the "normal" position of each manual valve noted,

equipment, and the type, location, and setpoints of each safety relief valve and thermal relief valve.

e. A certified pipeline inventory - a detailed list with sizes, lengths, quantity, and volumes must be provided for the systems in this project. Such systems include, but are not limited to: marine receipt, pipeline receipt, truck off-loading receipt, pumphouse, pump pad, truck loading, marine loading, transfer pipeline, product recovery, and other miscellaneous piping systems. Fuel system volume must be calculated using as constructed pipe lengths, internal diameters, fittings, and components. Totals must be provided for all items containing fuel with the exception of tanks which is covered by other specifications.

1.6 QUALITY ASSURANCE

1.6.1 Contractor Start-Up Qualifications

Submit the following data for approval:

a. Certification stating that the Contractor has provided start-up services (including start-up, existing system cleanliness confirmation, and performance testing experience) for five similar systems in the last five years.

b. Project names, locations, system description, and items provided at these installations. Include user point-of-contact and current telephone numbers.

1.6.2 Certification of Entire System

Prior to the acceptance of the newly constructed system by the Government, all installed mechanical and electrical system components must be inspected and approved by the Contracting Officer. Provide the Contracting Officer 60 days notice in order to schedule the Installation and Service Headquarters and/or their designated appointee for participation in the inspection, Performance Testing, and approval. Any deficiencies observed must be corrected by the Contractor without cost to the Government.

1.6.3 Service Headquarters Definition

SME is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (AFCEC/COS); Army - Headquarters, U.S. Army Corps of Engineers; POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC); Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11). ER 1110-1-8167 Engineering and Design Petroleum, Oil, and Lubricants Mandatory Center of Expertise must be followed.

The Service Control Point (SCP) is defined as follows: Army - Army Petroleum Center; Air Force - Air Force Petroleum Office; Navy/Marine Corps - Naval Supply Systems Command - Energy.

1.7 SYSTEM SUPPLIER INVOLVEMENT

The System Supplier is defined in Specification 33 57 55 FUEL SYSTEMS COMPONENTS (NON-HYDRANT). The Contractor and the System Supplier must work together to prepare the Start-Up Plan, Equipment Testing Plan,

Performance Testing Plan, and the Final Reports. They must both be present during all activities described in this section. The System Supplier must be responsible to the Contractor for scheduling all Contractor, sub-Contractor, and manufacturer's service personnel during activities described in this specification section.

1.8 DISPOSAL OF WASTE MATERIALS

The Contractor must be responsible for properly disposing of any sludge, debris, filtration elements, and waste fuel resulting from piping and tank flushing activities as specified in Section 33 57 55. Comply with all applicable Installation, local (city and county), State, and Federal Regulations for hazardous waste disposal.

PART 2 PRODUCTS

2.1 GOVERNMENT-FURNISHED MATERIAL AND EQUIPMENT

The Government will furnish the following materials, equipment and services during the performance of the work under this section.

2.1.1 Fuel

Some fuel loss should be expected. Fuel that is lost during flushing , equipment testing, and performance testing is viewed as a Start-up and Performance Testing expense and should be budgeted for in Contractor estimates. As Basis of Bid, the Contractor must allow for 200 gallons of fuel losses in the bid.

The Contractor is responsible for the disposal of any waste product.

The Contractor must establish a Department of Defense Activity Address Code and must reimburse the US Government for any US Government fuel lost resulting from poor workmanship or contamination.

The Government will provide fuel given that the requirements are submitted with sufficient lead time to allow the US Government to secure the grade and volume required and make the necessary transportation requirements. The Contractor must provide a copy of the Start-up, Fuel Provisioning, and Performance Testing plans a minimum of 60 days in advance of System Start-up.

FLUSHING, EQUIPMENT TESTS and PERFORMANCE TESTING: The flushing, and testing phases will be identified separately in the start-up and Performance Testing plans. Fuel used for flushing, and testing will become contaminated, the fuel must be isolated and is considered off-specification until the quality can be verified. Fuel volumes required for flushing and testing should be minimized to limit costs, so estimates should be made accordingly. The Contractor will be responsible for disposing of any waste product.

Upon satisfactory completion of the flushing operations, the Government will supply the additional quantities of fuel required to complete the other work under this section. This larger volume of fuel will not be delivered to the system until the Contractor has satisfactorily completed all work and, in particular, the removal of preservatives and foreign matter from those portions coming in contact with the fuel valves, pumps, filter-separators and other such system components.

2.2 CONTRACTOR-FURNISHED MATERIAL AND EQUIPMENT

2.2.1 Contractor-furnished

Provide material, equipment and labor not specified to be Government-furnished and required for proper System Start-Up of the system. Equipment being provided must be calibrated and the certificate of calibration be submitted to the Contracting Officer prior to use. Equipment must include but not be limited to the following:

a. Temporary strainers.

b. Pipe spools.

c. Flow meters.

d. Pressure gauges.

e. Electronic sensors and recorders for pressure are included in the Pump Control Panel (PCP). This equipment must be used to monitor and record the system during the "Equipment Tests" and "Performance Testing" portions of this Specification Section. Recorded data must be used by the Contractor and equipment factory representatives to achieve final control valve and equipment adjustments. Recorded data must include:

   (1) Fueling pumps discharge pressures.

   (2) Storage Tank levels.

   (3) Product Recovery Tank levels.

   (4) Fueling pumps suction pressures.

   (10) Back Pressure Control Valve downstream pressures.

   (11) Bypass Pressure Control Valve upstream pressures.

   (12) Bypass Pressure Control Valve downstream pressures.

f. The Contractor must have on hand sufficient filter elements and coalescer cartridges to adequately clean the system. During the cleaning operation, provide a flow versus pressure drop graph for each filter-separator, as provided in Attachment 1 - Equipment Tests. Change coalescers and cartridges upon reaching a differential pressure of 15 psi or when pressure drop is less than previous graph or fails to increase properly. Isolate each filter-separator, one at a time and use one fueling pump to obtain rated flow rate 300 gpm . A minimum of one complete set of coalescer elements and separator cartridges for each filter-separator must be turned over to the Government after new coalescer elements and separator cartridges are installed in each filter-separator vessel after completion of Performance Testing.

n. The Contractor must be responsible for providing the electrical power from a source identified by the Government to the testing locations.

o. Temporary filtration/strainers.

2.2.2 Design Conditions

Use temporary flushing lines and equipment that are equal in strength, stability, and materials to the associated permanent components. However, spools may be carbon steel. Additional design conditions must be as specified in Section 33 57 55 FUEL SYSTEMS COMPONENTS (NON-HYDRANT).

2.2.3 Electric Power

Electric power required for the performance of the work under this section must be furnished by the Contractor.

PART 3 EXECUTION

3.1 SEQUENCE OF EVENTS

The following events take place in the Start-Up and Performance Testing of a system and their definitions:

a. System Start-Up Phase: The System Start-Up phase encompasses all of the events described below up to the Performance Tests Phase.

b. Preliminary Requirements: Confirms completion of the system before fuel is received.

c. Preparations for Flushing: Activities that take place before initial receipt of fuel.

d. Pneumatic Testing: Test for leaks in a piping system using air under pressure as the test medium. For requirements see Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

e. Hydrostatic Testing - Water: Use of water to test for leaks in a piping system using liquid under pressure as the test medium. For requirements see Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

f. Hydrostatic testing - Fuel: Use of fuel to test for leaks in a piping system using liquid under pressure as the test medium. For requirements see Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

g. Soak Testing: Perform "Soak Testing" of the piping system using fuel, as per Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT)

h. Flushing: In this context, refers to removing gross contamination (free water and solids) from a fuel system using fuel.

i. Cleaning (filter vessels and strainers): Filter vessels and strainers that are designed to be opened for cleaning must be opened and cleaned.

j. Control Valve Adjustment: Control valve adjustment so that equipment can be safely tested and adjusted.

k. Equipment Tests: Tests performed by the Contractor and the System Supplier to confirm that individual components of the fuel system are correctly installed and are operational.

l. Performance Tests Phase: Government witnessed demonstration of the proper operation of the individual pieces of equipment and the system

or systems as a whole.

3.2 PRELIMINARY REQUIREMENTS

All activities listed in paragraph PART 3 EXECUTION must be performed sequentially in the order they are presented. Prior to any on-site system start-up activities, the Contractor must ensure that all requirements of the paragraph SAFETY are satisfied. Project must be substantially complete, except for touch-up field painting, and Contractor's work area must be free of debris, trash and obstacles. Perform the following activities prior to receipt of fuel:

3.2.1 Safety

Prior to any on-site system start-up activities, the following safety procedures must be accomplished in all fueling areas to be started up and performance tested under this specification section: testing/operation of emergency showers and eyewash stations, placement of Contractor-provided portable eyewash units within 100 feet or 10 seconds from the fueling point, verification of proper grounding throughout system, coordination with Government Fire and Safety Office and Fuels personnel, placement of Contractor-provided spill pads, placement of Contractor-provided fire extinguishers capable of extinguishing a fuel fire. Ensure that all radios/devices at all Class I, Division 1 areas are intrinsically safe.

3.2.2 Electrical Preparations

Prior to energizing the electrical system components, verify that short-circuit links have been removed from current transformer and that secondary circuits have been connected. Confirm that all tests required for fire detection and suppression systems have been performed and accepted. Verify all electrical transmitter connections and ensure proper calibration. Verify all electrical system components meet the classification and division as required by the design. Verify correct rotation of all motors prior to testing. Verify paddle type flow switches by physically actuating vanes and checking outputs. Conduit explosion-proof sealoffs must be poured after initial electrical checks but before fuel receipt.

3.2.3 Emergency Fuel Shutoff (EFSO) System Testing

Prior to initial fuel receipt, verify that each switch will trip the circuit breaker of the fuel pumps.

3.2.4 Piping System

Ensure that all piping weld integrity, leak detection systems, and coating inspections have been performed per the applicable specifications. Provide statement that required testing has been completed in the Final Reports. Evacuate all accumulated water from piping low point drains, valve cavities, and equipment drains. Verify all bolted connections are tightness tested to required torque using a calibrated torque wrench. Verify that all pressure gauges are properly calibrated, located and installed. Ensure that piping's cathodic protection system is tested, calibrated and operational. Ensure that pipe marking and identification are provided as specified. Ensure that piping system thermal relief provisions are installed as designed. Verify the correct installation of piping expansion loops and supports.

3.3 PREPARATIONS FOR FLUSHING

Upon completion of the system to the satisfaction of the Contracting Officer and the Service Headquarters and/or their designated appointee, make the following preparations for flushing the system.

3.3.1 Protection of System Components

The following items must be removed from the system prior to start of flushing operations and, where applicable, replaced with spools of pipe, diameter equal to the item removed.

a. Control valves. This also includes control valve tubing exterior to the valve such as that which runs from tank level control valves up to tank float pilots.

b. Sensors which are exposed to the fluid such as pressure gauges and thermometers.

c. Coalescer and separator elements in filter-separators.

d. Meters.

After flushing, the above items must be reinstalled in the system and the spool sections turned over to the Contracting Officer.

3.3.2 Strainers

Ensure strainers are clean before flushing. Temporary 60 mesh strainers with minimum 300 percent open area must be provided in the suction line ahead of each fueling pump to remain permanently in the system. Any damaged permanent or temporary strainers must be replaced by the Contractor at no additional cost to the Government.

3.3.3 Water Draw-off

Remove any accumulated water from piping, equipment, and storage tanks' sumps and bottoms. Drain water and return fuel via filtration to storage tank. Repeat process until all water is removed. Dispose of petroleum contaminated water in accordance with Installation, local, State, and Federal regulations.

3.4 INITIAL FUEL RECEIPT INTO STORAGE TANK

3.4.1 General

Utilize one storage tank for initial fuel receipt to isolate contaminated fuel. Initial receipt of fuel must be done by gravity if possible. The Contractor must station personnel throughout piping system at high point vents to bleed air. All flanges and system components will be periodically inspected for leaks during filling procedures.

3.4.2 Storage Tanks

Receipt flow rate into an empty storage tank must not exceed 3 feet per second (FPS), as measured in the main receipt piping, until outlet of tank fill tube is submerged.

3.4.3 Components

Ensure that filter-separators and other vessels are filled slowly by closing outlet valves and venting through air eliminators. Fill filter vessels using slow-fill line to maintain a packed condition in vessels throughout initial fill of piping system. Differential pressure across strainers must be continuously monitored. Any time a strainer differential pressure reaches 20 psig, it must be cleaned.

3.4.4 Fuel Quality

Fuel used during initial receipt must be considered contaminated and must be positively isolated, with blind flanges or closed, padlocked manual valves, from any active transfer, or tank truck loading operations. Fuel isolation must continue until all flushing is completed. A method of checking fuel quality that is acceptable to the Contracting Officer must be provided at the beginning and end of any new piping section.

3.4.5 Fuel Receipt

3.4.5.1 Fuel Receipt by Commercial Truck

Start-up personnel must meet with Government personnel in charge of existing fuel storage to discuss fuel transfer procedures. Topics must include: methods of communication to start/stop pumps; flow rate and head characteristics of transfer pumps; methods of restricting initial receipt flow rate; methods of straining and filtering initial receipt fuel; accommodating multiple pump starts resulting from required strainer and filter cleaning operations; required quantity of fuel to be transferred. Coordinate with Government personnel to schedule quantity of trucks required. Contractor's personnel must be positioned at each offloading position, at the pumphouse and at the receipt tank, all in radio contact. Contractor must provide a written summary of truck receipt procedures to the Contracting Officer. If truck unloading system is newly constructed, perform initial receipt, flushing, and testing prior to performance testing.

3.4.5.2 Fuel Receipt from Piping System

Start-up personnel must meet with Government personnel in charge of existing fuel storage to discuss fuel transfer procedures. Topics must include: methods of communication to start/stop remote pumps; flow rate and head characteristics of pumps; methods of restricting initial receipt flow rate; methods of straining and filtering initial receipt fuel; accommodating multiple pump starts resulting from required strainer and filter cleaning operations; required quantity of fuel to be used. Contractor must provide a written summary of piping fill procedures to the Contracting Officer.

3.4.6 Initial Low Point Flush

Perform an initial low point flush operation by flushing each low point drain through a portable basket strainer for 10 seconds at a system pressure of 30 psig. Repeat flush until basket strainer collects no additional debris.

3.4.7 Storage Tank Tightness Tests

Perform tightness testing and manufacturer's tests of the storage tanks per Specification Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

3.4.8 Piping Hydrostatic Tests

Hydrostatically test the piping system with fuel as required by Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

3.4.9 Piping Soak Tests

Upon completion of hydrostatic testing with fuel, perform "Soak Testing" of the piping systems per API RP 1595. Duration of the test must be a minimum of 4 days and maximum of 7 days.

3.5 INITIAL FUEL RECEIPT DIRECTLY INTO PIPING SYSTEM

3.5.1 General

Initial receipt of fuel must be done by gravity if possible. The Contractor must station personnel throughout piping system at high point vents to bleed air. All flanges and system components will be periodically inspected for leaks during filling procedures.

3.5.2 Components

Ensure that filter-separators and other vessels are filled slowly by closing outlet valves and venting through air eliminators. Downstream valves must be throttled to maintain a packed condition in vessels throughout initial fill of piping system. Differential pressure across strainers must be continuously monitored. Any time a strainer DP reaches 20 psig, it must be cleaned.

3.5.3 Fuel Receipt

3.5.3.1 Fuel Receipt from Existing Piping System

Start-up personnel must meet with Government personnel in charge of existing fuel system to discuss fuel transfer procedures. Topics must include: methods of communication to start/stop remote pumps; flow rate and head characteristics of pumps; methods of restricting initial receipt flow rate; methods of straining and filtering initial receipt fuel; accommodating multiple pump starts resulting from required strainer and filter cleaning operations; required quantity of fuel to be used. Contractor must provide a written summary of piping fill procedures to the Contracting Officer.

3.5.4 Initial Low Point Flush

Perform an initial low point flush operation by flushing each low point drain through a portable basket strainer for 10 seconds at a minimum system pressure of 30 psig. Repeat flush until basket strainer collects no additional debris.

3.5.5 Piping Hydrostatic Tests

Hydrostatically test the piping system with fuel as required by Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

3.5.6 Piping Soak Tests

Upon completion of hydrostatic testing with fuel, perform "Soak Testing"

of the piping systems per API RP 1595. Duration of the test must be a minimum of 4 days and maximum of 7 days.

3.6 FLUSHING

Flushing procedures remove gross particulate and water contaminants. All piping including but not limited to receipt piping,issue piping, product recovery lines, truck off-loading lines, thermal relief piping, high point vents, low point drains, control valve tubing on the control valves, must be flushed with fuel.

In the event flushing identifies the presence of clay or soil like material in the system, Contractor must immediately notify Contracting Officer for direction.

3.6.1 Flushing Requirements

Begin flushing of fuel system piping at low flow rates using one pump in multiple pump systems at 50 percent of rated flow. Slowly increase flushing flow rate until a plus or minus 12 FPS fuel velocity is achieved. Flush for one piping volume. For gravity, suction, or other non-pumped piping segments, minimum flushing volume must be four times the pipe volume. Sampling must be performed by the Contractor and testing must be done by an independent fuels testing laboratory approved by the Contracting Officer. Fuel must be free of gross contamination and visible free water to the satisfaction of the Contracting Officer.

In the event flushing identifies the presence of clay or soil like material in the system, Contractor must immediately notify Contracting Officer for direction.

3.6.2 Fueling System Piping

During flushing procedure periodically bleed air through high point vent and drain water through low point drains.

3.6.2.1 General Fuel Lines

The flushing of all of the system piping segments must be accomplished by pumping fuel through the fueling system piping and back into the same tank the fuel was withdrawn from. Air must be bled from system high points. The procedure must be continued until the fuel being delivered into the tanks is acceptable to the Contracting Officer. After the piping system segments have been flushed to the satisfaction of the Contracting Officer (and periodically during the flushing operation), the Contractor must flush all high point vents and low point drains for a minimum of 10 seconds at a pressure of 30 psig. Flush all plug valves of debris using the drain port at the bottom of the valve. Cone strainers must be kept clean in order to insure maximum flow rate. All accumulated material from the strainers must be reviewed and identified, including source if possible. Upon completion of the first flushing operations, the cone strainers must be cleaned, reinstalled, and remain in the system. In addition, baskets from all strainers must be removed and cleaned.

3.6.2.2 Truck Offloading System Piping

Flushing of the truck offloading system and piping must occur during the receipt operations. Samples of the incoming fuel must be taken at the point of connection with the OTR tank truck. Sample the fuel into and out

of each offloading station.

3.6.2.3 Pump Pad Piping

Remove system components as specified in paragraph PROTECTION OF SYSTEM COMPONENTS. Perform the following flushing operations by withdrawing fuel from one tank and returning it to another tank. Circulate a sufficient amount of fuel for each operation. Bleed air from high points.

a. Position manual valves to circulate fuel through one pump, filter-separator combination.

3.6.3 Piping Flushing Checklist

The Contractor must generate a comprehensive matrix of all new and existing piping sections in the system. Matrix must serve as an Owner's piping inventory and a checklist for all Contractor-provided flushing operations. Column entries must include pipe section name, location, diameter, approximate length, flushing fuel velocity and volume achieved and acceptable results of sampling.

3.7 CONTROL VALVE ADJUSTMENT

Check all control valve settings and field adjust from the factory settings at System Start-Up as necessary to provide a smooth operation, devoid of pressure surges, spikes, and hunting. Check the filter separator control valves and adjust as follows:

3.7.1 Control Valves on Issue Filter-Separator Downstream Side

a. Position valves so that one fueling pump can pump through only one filter-separator. Close the valve at the entrance of the apron loop, and open the bypass valve, allowing discharge into the circulating line.

b. Start the pump and adjust the filter-separator control valve for the rated flow capacity of the filter-separator at nominal rated flow.

c. Repeat above for each remaining filter-separator.

3.8 EQUIPMENT TESTS

After completion of flushing,, Contractor must complete and submit the Equipment Tests (see Attachment 1 - Equipment Tests). Equipment Tests must be submitted prior to Performance Testing

3.8.1 Control System and Control Valves

Field adjustment of automatic control valves and automatic pump controls while in operation must be made only by the valve manufacturer's authorized field test engineer. . Both the mechanical and electrical components must be adjusted concurrently. Record required data necessary to prepare Equipment Tests Report.

3.8.2 Tank Level Alarms

Position valves to transfer fuel between tanks.

Start fueling pump and pump sufficient fuel out of the first tank to allow

the low-low level alarm (LLLA) to stop the fueling pump. Repeat procedure for each fueling pump and each tank until the low-low level alarm stops the fueling pumps due to low liquid level in tank.

Repeat testing for high-high level alarm other alarms checking each one in turn. Repeat procedure for each fueling pump and each tank until the high-high level alarm closes the valve due to high liquid level in tank.

3.8.3 Fueling Pump Operation

Demonstrate operation of all pump control start/stop station to start and stop the fueling pumps in the presence of the Contracting Officer. Repeat the operating sequence with each of the pumps being selected as lead pump if the pumps are controlled by a Pump Control Panel or an automatic control system with a variable lead pump. For this test, measure the flow rates. Witness and record flow rates and test results.

3.8.4 Emergency Shutdown

With one fueling pump circulating fuel through the system, test each "Emergency Stop" pushbutton station to verify that the pump stops . Repeat above procedure for each fueling pump and "Emergency Stop" pushbutton station. Conduct tests for both the automatic and manual modes. With all the fueling pumps circulating fuel through the system, push an "Emergency Stop" pushbutton station.

3.9 PERFORMANCE TESTS

Performance testing must occur after the Contractor has performed the Equipment Tests. Performance testing must demonstrate to the satisfaction of the Contracting Officer and Service Headquarters and/or their designated appointee these portions of the fueling system are working as specified. Performance testing must consist of repeating the Equipment Tests (indicated in previous paragraphs) and operating the fueling system during actual operations in the presence of Government Witnesses. The maximum rated capacity of the system must be demonstrated. The Contractor must notify the Contracting Officer 30 calendar days in advance of the test to permit arrangement for the use of Government-furnished items. During the time period of performance testing, no construction activities will be allowed on the project site. The project site must be considered an operational (fuel) zone (verses a construction zone) during this performance testing period. Personnel, dressed for fuel's operation, will be present to witness testing and participate in Contractor provided training.

3.9.1 Final Performance Test

A final performance test must consist of demonstrating the operation of the system for the purpose for which it is intended:

a. off-loading over the road tank trucks
b. transferring fuel through the piping system

3.9.2 Satisfactory Performance

In the event a portion of the system or any piece of equipment fails to meet the test, make the necessary repairs or adjustments and repeat the Performance Test until satisfactory performance is obtained. The determination of satisfactory performance must be made by the Contracting Officer and the Service Headquarters and/or their designated appointee.

3.9.3 Performance Testing Plan

Contractor must edit the example Performance Testing plan and submit for approval. An example Performance Testing plan can be found at the end of this Section as Attachment 2 - Performance Testing Plan. Submit plan a minimum of 60 days prior to performance testing.

3.9.4 Equipment Tests

Contractor must provide 10 hard copies and electronic copies of the completed Equipment Tests to the Service Headquarters and/or their designated appointee at the start of Performance Testing for validation during Performance Testing.

3.9.5 Final Acceptance

Fill the system with fuel and operate leak-free prior for acceptance. Anything wet with fuel is considered to be leaking.

3.9.5.1 Tank High Liquid Level Shut-Off Valve Test and Adjustments

During the final filling of tanks, check the tank automatic high liquid level shut-off valve for proper functioning at least three times by lowering the fuel level and refilling again. Adjust valve to achieve a safe fill level.

3.9.5.2 Tank Level Indicator Adjustments

Also, during the final filling of tanks, adjust and calibrate the tank level indicators including the final setting of the high high level (HHLA) and high level (HLA) alarms. Since the HHLA is at a point higher than the High Liquid Level Shut-Off Valve float set point, an artificial method of simulating HHL must be used.

-- End of Section --

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SECTION 33 09 52

FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT)
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 18.1	(1979; R2004) Annunciator Sequences and Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA IA 2	(2005) Programmable Controllers - Parts 1 thru 8
NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UL SOLUTIONS (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 1012	(2010; Reprint Apr 2016; Rev Mar 2021) UL Standard for Safety Power Units Other than Class 2
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.2 ADMINISTRATIVE REQUIREMENTS

a. Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section, with the additions and modifications specified herein.

b. Programmable Logic Controllers (PLCs) receive information from motor operated valved, position indicated ball valves, automatic tank gauging/independent level alarm probes and sensors, and other devices to control the fueling system.

c. The control system must be furnished by a single supplier. See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT) for other required components of the control system. The control system supplier must be responsible for providing a fully functional control system, in accordance with the drawings and specifications, including the field devices. Installation must be in accordance with NFPA 70.

d. Submit six copies of Operation and Maintenance Manuals, within 7 calendar days following the completion of factory tests. Installation, Operation, and Maintenance manuals for all system components supplied must be furnished following the completion of shop tests and must include:

(1) Pump Control Panels and Fiber Converter Panels including interior and exterior system components layout. Complete guide outlining step-by-step procedures for system startup and operation.

(2) All documents previously submitted and approved with all comments and field changes annotated. Complete description of the sequence of operation including that described in PART 3 and any subsystems not controlled by the PLC (e.g. alarm annunciator safety/circuit).

(3) Complete listing of all programming of the PLCs, and laptop computer.

(4) Complete relay ladder logic diagrams, PLC input/output diagrams and control power distribution diagrams for the complete control system.

(5) Complete troubleshooting guide, which lists possible operational problems and corrective action to be taken, including all as-built conditions.

e. Submit documents demonstrating the accuracy and completeness of the list of material and components, that items proposed comply fully with contract requirements, and are otherwise suitable for the application

indicated. Documents must consist of all data or drawings published by the manufacturer of individual items listed including manufacturer's descriptive and technical literature, performance data, catalog cuts, and installation instructions. Submit additional material if the listed items are not adequate to identify intent or conformance to technical requirements. Provide typed and electronic copies of these lists for approval. Any delays associated with resubmittals of incomplete or ambiguous initial submittals will be the Contractor's responsibility.

f. Documents must be bound in a suitable binder adequately marked or identified on the spine and front cover. A table of contents page must be included and marked with pertinent contract information and contents of the manual. Tabs must be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets must be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawing; G, DO

SD-03 Product Data

Tools and Spare Parts

Laptop Computer; G, DO

Programmable Logical Controller (PLC) Hardware and Software; G, DO

Control Wiring Data Lists; G, DO

Human Machine Interface (HMI) Touchscreen; G, DO

Fiber Converter Panels (FCP) and Components; G, DO

Pump Control Panels (PCP) and Components; G, DO

Graphics Display Screen; G, DO

SD-06 Test Reports

Certified Pump Control Panels (PCP) Shop Test Reports; G, DO

Record of Test

SD-07 Certificates

Experience and Qualifications; G, DO

Testing Plan; G, DO

Training Plan for Instructing Personnel; G, DO

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, DO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 TOOLS AND SPARE PARTS

Provide the following:

a. Any special tools necessary for operation and maintenance of the system components providing supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

b. One spare set of fuses of each type and size.

c. Recommended manufacturer list of spare parts, including part number, current unit price, and source of supply.

d. One spare power supply module.

e. One spare I/O module for discrete devices.

f. Two PLC RAM back-up batteries.

1.5 EXPERIENCE AND QUALIFICATIONS

Submit the following data for approval:

a. Certification stating that the manufacturer has manufactured, installed, and successfully completed at least five PLC-based systems for automatic cycling of pumps based upon varying dispensing demands ranging from 0 to 2400 GPM utilizing multiple pumps.

b. Certification that the control systems have successfully operated over the last 2-years and are currently in service.

c. Project names, locations, and system description of these installations. Include user point-of-contact and current telephone numbers.

1.6 WARRANTY

The Pump Control and Annunciation System including devices, hardware and software must be warranted for a period of one year from the date of acceptance of the system by the Government. This warranty service must include parts and labor service for system components supplied under this specification. Upon notification by the Government of system or component failure, respond at the site with necessary parts within 48-hours of notification.

PART 2 PRODUCTS

2.1 MATERIALS AND SYSTEM COMPONENTS

2.1.1 Pump Control Panels (PCP) and Components

NEMA ICS 1, NEMA ICS 6, NEMA 250, and UL 508. The PCP enclosure must be a freestanding NEMA Type 12, smooth, gasketed enclosure constructed of 12 gauge steel. All seams must be continuously welded and there must be no drilled holes or knockout prior to delivery to the job site. The pump control panel dimensions must be a maximum of 90-inches high, maximum 36-incheswide, and a maximum of 24-inches deep and must have removable lifting eyes. The interior surfaces of the panel must be properly cleaned, primed, and spray painted with white high-gloss enamel. Exterior surfaces must have standard factory finish. Access for the PCP must be front only and must consist of hinged doors having 3-point latching mechanisms. The doors must open approximately 120 degrees. Rack mounting angles, swing-out panels and other component mounting hardware must be installed such that servicing of one component must not require removal or disconnection of other components. No clearance will be required between the back of the panel and the room walls. Terminal facilities must be arranged for entrance of external conductors from the top or bottom of the enclosure.

2.1.2 Fiber Converter Panels (FCP) and Components

NEMA ICS 1, NEMA ICS 6, NEMA 250, and UL 508. The FCP enclosure must be a rack mounted NEMA Type 4X, stainless steel 316L, smooth, gasketed enclosure constructed of 14 gauge steel. All seams must be continuously welded and there must be no drilled holes or knockout prior to delivery to the job site. The FDP dimensions must be a maximum of XX-inches high, maximum XX-incheswide, and a maximum of XX-inches deep. Exterior surfaces must have standard factory brushed finish. Access for the FCP must be front only and must consist of hinged doors having 3-point latching mechanisms. The doors must open approximately 120 degrees. Rack mounting angles, swing-out panels and other component mounting hardware must be installed such that servicing of one component must not require removal or disconnection of other components. Terminal facilities must be arranged for entrance of external conductors from the top or bottom of the enclosure.

2.1.3 Ventilation System

Provide one supply fans, single phase, 115 volt. Each fan must supply a minimum of 100 CFM. The supply and exhaust grill must contain a filter that is easily removed from the exterior of the enclosure. Also provide two thermostats with an adjustable set point range of 70 degrees F to 140 degrees F. Locate the thermostats near the top in the interior of the PCP.

2.1.4 Ground Bar

The control panel must have a tin-plated copper equipment ground bar. The bar must have a minimum of twenty grounding screws.

2.1.5 Human Machine Interface (HMI) Touchscreen Terminals

Provide HMI touchscreens in locations as provided on the drawings. Touchscreen terminal must be industrial grade. The touchscreen terminal must be a minimum of 15-inches SGA TFT LED LCD. Provide the latest Intel Atom process operating at aminimum of 1.91 GHz quad core processor with a

minimum of 4 GB DDR3L SDRAM and 64G SSD. Touchscreen terminal operating temperature should range from -4 degrees F to 140 degrees F. The cooling system must be fanless. The touchscreen terminal must be a minimum of 36 million touches at a single point. The touchscreen terminal type must be 5 wire analog resistive. Input and Output connections must include one RS-232, one RS-232/422/485, one USB 3.0, three USB 2.0 and any other connection type to make a complete operational system.

2.1.6 Standard Indicator Lights

NEMA ICS 1, NEMA ICS 2, and UL 508. Lights must be heavy duty, NEMA 13, 1-inch mounting hole, round indicating lights operating at 120 volts ac/dc or 24 volts ac/dc. Long life bulbs must be used. Indicator lights must have a legend plate with words as shown on drawings. Lens color as indicated on the drawings. Lights must be "push to test (lamp)" type. LED type lamps of comparable size and color may be substituted for standard indicator lights.

2.1.7 Selector Switches

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated lever operated selector switches must be heavy duty, NEMA 13, round, and utilize a 7/8-inches mounting hole. They must have the number of positions as indicated on the drawings. Switches must be rated 600 volt, 10 amperes continuous. Legend plates must be provided with each switch with words as indicated on the drawings.

2.1.8 Pushbuttons

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated pushbuttons must be heavy duty, NEMA 13, round, utilize a 7/8-inch mounting hole, and have the number and type of contacts as indicated on the drawings or elsewhere in the specifications. The emergency stop switch must be a red mushroom head, 1.5inch diameter, momentary contact type. Pushbuttons must be rated 600 volt, 10 amperes continuous. Legend plates must be provided with each switch with words as indicated on the drawings.

2.1.9 Relays

IEEE C37.90, NEMA ICS 2, UL 508.

2.1.10 Nameplates

Nameplates must be made of laminated plastic with black outer layers and a white core. Edges must be chamfered. Nameplates must be fastened with black-finished round-head drive screws or approved nonadhesive metal fasteners.

2.1.11 Transient Voltage Surge Suppression Devices

IEEE C62.41 for Category "B" transients, UL 1449.

2.1.12 Terminal Blocks

NEMA ICS 4. Terminal blocks for conductors exiting the PCP must be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks must be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip must form

part of the terminal block and each terminal must be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.1.13 Circuit Breakers

UL 508. Individual, appropriately sized, terminal block mounted, circuit breakers must be provided for all 120 volt PCP mounted system components and for the 120 volt terminal boards shown on the drawings.

2.1.14 Uninterruptible Power Supplies

UL 1012. Input voltage must be 120 volts (nominal), 1 phase, 60 Hertz. Output voltage regulation must be plus/minus 5.0 percent for the following conditions:

a. 20 to 100 percent load on output.

b. Input voltage variation of minus 15 to 10 percent.

c. Constant load power factor between 80 and 100 percent.

Response time must be 1.5 cycles or less. Battery capacity must be such as to provide an orderly shut down of operating programs or as a minimum 10 minutes.

2.1.15 Miscellaneous Power Supplies

UL 1012. Certain field devices may require power other than 120 VAC (i.e. 24 VDC). The power supplies must be convection cooled, have fully isolated independent outputs, have constant voltage, have short circuit and overvoltage protection, and have automatic current limiting.

2.1.16 Alarm Horns

UL 508. The alarm horns must consist of vibrating horns and resonating horns as shown on the drawings. One vibrating horn is to be mounted on each Fiber Converter Panel, and two vibrating and two resonating horns must be mounted outside of Building 451 as shown on the drawings. The exterior horns must each produce 100 db at 10 feet and must be provided in a weather proof housing. The PCP and FCP horns must produce 70 db at 10 feet.

2.1.17 Laptop Computer

2.1.17.1 Hardware

The following are the minimum hardware requirements for the laptop computer:

a. Latest Core i9 CPU operating at 5.4 GHz or faster

b. 16 GB RAM

c. 1 TB hard drive SSD

e. 16-inch 1920 x 1200 LED - Backlit Display

f. Keyboard

g. Pointing device (e.g. mouse, track ball)

h. 120VAC and Battery power supply

i All cables and connectors for interfacing with PLCs

j. One HDMI Port

k. Three USB 3.2 communications ports

l. Provide a carrying case for the Laptop Computer

2.1.17.2 Software

The following is the minimum software to be loaded on the laptop. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed (provide with software key) and come with all devices to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating system)

b. Software for programming the PLCs

2.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

2.2.1 General

a. NEMA IA 2. PLC must be able to receive discrete and analog inputs and through its programming it must control discrete and analog output functions, perform data handling operations and communicate with external devices and remote I/O racks. PLC must be a modular, field expandable design allowing the system to be tailored to the process control application. The capability must exist to allow for expansion to the system by the addition of hardware and user software. At a minimum the PLC must include mounting backplanes, power supply modules, CPU module, communication modules, and I/O modules.

b. Design and test PLC provided for use in the high electrical noise environment of an industrial plant. PLC module must comply with the FCC Part 15 Part A for radio noise emissions. The programmable controller processor must be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2, IEEE C37.90.

c. PLC must function properly at temperatures between 32 and 122 degrees F, at 5 to 95 percent relative humidity non-condensing and have storage temperatures between minus 40 and 140 degrees F at 5 to 95 percent relative humidity non-condensing.

d. PLC must have manufacturer's standard system status indicators (e.g. power supply status, system fault, run mode status, back-up battery status).

2.2.2 Central Processing Unit Module

The CPU must be a modular self-contained unit that will provide time of day, scanning, application (ladder rung logic) program execution, storage of the application program, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self-diagnostics.

2.2.3 Power Supply Module

a. The power supply module must be plugged into the backplane not separately mounted. The power supply must be wired to utilize 120 VAC, 60 Hz power, the system must function properly within the range of minus 10 to plus 15 percent of nominal voltage. The power supply must provide an output to the backplane at a wattage and voltage necessary to support the attached modules. A single main power supply module must have the capability of supplying power to the CPU module and local communication and I/O modules. Auxiliary power supplies must provide power to remote racks.

b. Each power supply must have an integral on/off disconnect switch to the module. If the manufacturers standard power supply does not have an on/off disconnect switch a miniature toggle type switch must be installed near the PLC and clearly labeled as to its function.

c. The power supply must monitor the incoming AC line voltage for proper levels and have provisions for both over current and over voltage protection. If the voltage level is detected as being out of range the system must have adequate time to complete a safe and orderly shutdown.

2.2.4 Program Storage/Memory Requirements

a. The PLC must have the manufacturers standard nonvolatile executive memory for the operating system. The PLC must also have EEPROM (Electrically Erasable Programmable Read Only Memory) for storage of the user program and battery backup RAM for application memory. The EEPROM must be loaded by use of the laptop computer.

b. Submit a calculation of the required amount of EEPROM and RAM (random access memory) needed for this application plus an extra 50 percent.

c. The number of times a normally open (N.O.) or normally closed (N.C.) contact of an internal output can be programmed must be limited only by the memory capacity to store these instructions.

2.2.5 Input/Output (I/O) Modules

a. Provide all required I/O modules (analog input, analog output, discrete input, discrete output, and isolated discrete output) to manipulate the types of inputs and outputs as shown on the drawings and to comply with the sequence of operations. Also provide a minimum of 20 percent (round up for calculation) spare input and output points of each type provided, but not less than 2 of each type.

b. I/O modules must be a self-contained unit housed within an enclosure to facilitate easy replacement. All user wiring to I/O modules must be through a heavy-duty terminal strip. Pressure-type screw terminals must be used to provide fast, secure wire connections. The terminal block must be removable so it is possible to replace any input or

output module without disturbing field wiring.

c. During normal operation, a malfunction in any remote input/output channel must affect the operation of only that channel and not the operation of the CPU or any other channel.

d. Isolation must be used between all internal logic and external power circuits. This isolation must meet the minimum specification of 1500 VRMS. Provide optically isolated I/O components which are compatible with field devices.

e. Each I/O module must contain visual indicators to display ON/OFF status of individual input or output points.

f. Discrete output modules must be provided with self-contained fuses for overload and short circuit protection of the module.

g. All input/output modules must be color coded and titled with a distinctive label.

2.2.6 Interfacing

The PLC must have communication ports and communication modules using the manufacturers standard communication architecture for connections of the FCPs, other PCP, and Laptop Computer.

2.2.7 Program Requirements

a. The programming format must be ladder diagram type as defined by NEMA IA 2.

b. There must be a means to indicate contact or output status of the contact or output on the LCD screen (of the laptop computer). Each element's status must be shown independently, regardless of circuit configuration.

c. The program must be full featured in its editing capabilities (e.g. change a contact from normally open to normally closed, add instructions, change addresses).

2.2.8 Diagnostics

The CPU must continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and I/O. The diagnostic routines must be regularly performed during normal system operation. A portion of the scan time of the controller should be dedicated to perform these housekeeping functions. In addition, a more extensive diagnostic routine should be performed at power up and during normal system shutdown. The CPU must log I/O and system faults in fault tables, which must be accessible for display. When a fault affects I/O or communication modules the CPU must shut down only the hardware affected and continue operation by utilizing healthy system components. All faults must be annunciated on the alarm annunciator.

PART 3 EXECUTION

3.1 PUMP CONTROL PANELS (PCP) AND COMPONENTS

3.1.1 General

a. Where two or more system components performing the same function are required, they must be exact duplicates produced by the same manufacturer. All display instruments of each type must represent the same outward appearance, having the same physical size and shape, and the same size and style of numbers, characters, pointers, and lamp lenses.

b. The PCP must include all required resident software programs and hardware to provide the specified sequence of operation. All software optical discs, including programming manuals, must be turned over to the Government at the completion of start-up so modification can be done in the field with no outside assistance.

c. It is intended that process controlling devices except field devices, and motor controllers be attached to or mounted within each PCP enclosure and all interconnecting wiring installed prior to shipment to the job site. This is to allow shop testing of the system and to decrease field labor requirements.

d. The PCP must be shipped fully assembled in one piece after the completion of the shop tests and all defects corrected.

3.1.2 Wiring

Wiring methods and practices must be in conformance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 4, and NEMA ICS 6 recommendations as applicable. All wiring to instruments and control devices must be made with stranded wire, and wiring must be permanently labeled with conductor/wire numbers within one-inch of termination points. Labels must be tubular heat-shrinkable wire markers that remain legible after exposure to industrial fluids and abrasion. Position markers so that wire numbers can be read without disturbing or disconnecting wiring. Use of individual character-markers placed side-by-side is not acceptable. Numbers must match approved shop drawings. All wiring must be neatly laced from point of entry into enclosures to termination points with nylon lacing cord or plastic lacing ties. Lacing within wiring channels is not required. Where the PCP contains intrinsically safe wiring, barriers or other devices, the panel must be arranged so that all intrinsically safe wiring is separated from non-intrinsically safe wiring by approved methods. Wiring channels containing intrinsically safe wiring must be blue and be labeled as "Intrinsically Safe Wiring Only" on the cover. All conduit penetrations into the PCP containing intrinsically safe wiring must be separated from non-intrinsically safe conduit penetrations by a minimum of 2-inches. Provide typed Control Wiring Data Lists within each terminal cabinet and the PCP. The data lists must include: conductor identification number, wire gauge, wire insulation type, "FROM" terminal identification, "TO" terminal identification, and remarks. The preliminary lists generated by the Contractor will be submitted for approval to the Contracting Officer and will be updated to As-Built conditions by the Contractor. The As-Built data lists must be placed in a document holder within each enclosure.

3.1.3 Certified Pump Control Panels (PCP) Shop Test Reports

The manufacturer must shop test each PCP and laptop computer. The procedure must include simulation of field components and must provide for fully testing each pump control functions, fiber converter functions, and (HMIs) as a unit before delivery to the project site. The test must, reveal system defects, including, but not limited to, functional deficiencies, operating program deficiencies, algorithm errors, timing problems, wiring errors, loose connections, short circuits, failed components and misapplication of components. The test must be performed prior to shipment to the site and problems detected must be corrected. The final testing and correction sequence must be repeated until no problems are revealed and then two additional successful tests must be performed. Submit certified test report within 15-days after completion of the test. The report must include a statement that the Pump Control Panel performs as specified. Notify the Contracting Officer and the Service Headquarters 30-days prior to the final shop testing date. The Contracting Officer may require a Government witness at the final test before the PCP is shipped to the site.

3.1.4 Ventilation System

Thermostat T-1, must control fan F-1 and thermostat T-2 must control fan F-2. T-1 and T-2 must be set at 80 degrees F to maintain interior air temperature to 20 degrees F above ambient. Thermostat T-2 , set at 100 degrees F, must provide a non-critical PCP HIGH TEMPERATURE alarm to the alarm annunciator.

3.1.5 Grounding

The PCP ground bar must be connected to the building counterpoise via a #10 AWG conductor. Within the enclosure all I/O racks, processor racks, and power supplies must be grounded to meet the manufacturer's specifications.

3.1.6 Indicator Lights, Switches, and Pushbuttons

Indicator lights, switches, and pushbuttons must be mounted as shown on the drawings and must be arranged to allow easy vision and operation of each device. Each device must have a nameplate or legend plate as indicated on the drawings. Nameplate wordings must be as indicated on the drawings.

3.1.7 Surge Protective Devices

Surge protective devices (SPD) must be installed in the PCP to minimize effects of nearby lightning strikes, switching on and off of motors and other inductive loads. SPD must be provided for each control circuit ladder. Each ladder may contain any combination of the following devices: PLCs, power supplies (e.g., 24 volt), fans, relays, lights, switches. SPD must also be provided for PLC I/O originating outside of the building.

3.1.8 Terminal Blocks

As a minimum, any FCP or PCP device that connects to a field device (devices not located in the FCP or PCP) must be connected to a terminal block. A connection diagram similar to the drawings must be provided to the field Contractor for field connections to the FCP or PCP.

3.1.9 Circuit Breakers

As a minimum, any 120 volt FCP or PCP device i.e. (fans, lights, power receptacles, converter panels, 24 VDC power supplies, PLC CPUs, PLC I/O racks) must be provided with an individual circuit breaker. Additionally 120 volt terminal boards connecting to field devices (devices not located in the FCP or PCP) must be protected by a 120 volt circuit breaker.

3.1.10 Uninterruptible Power supplies

The PCP must contain two uninterruptible power supplies (UPS) (each connected to a dedicated circuit). As shown on the drawings one UPS must supply the PLC System , and the second UPS must supply the miscellaneous device power. The UPSs output capacity must be sufficient to drive all the system components connected plus 25 percent. The UPSs must be mounted on shelves near the bottom of the PCP but not rest on the floor of the PCP.

3.1.11 Power Supplies

Provide and install all 120 VAC and 24 VDC power supply. Interconnecting wiring between UPSs and PLC power supplies must be completely installed prior to shipment to the job site.

3.1.12 Alarm Annunciator and Horns

Signals must be initiated by PCP outputs as required. The control system must energize alarm horns, both an integral panel mounted vibrating horn and remote horns, and flash the appropriate HMI indicator. The minimum number of windows (on Human Machine Interface (HMI) Touch Screen) must correspond to the number of alarm points, plus 15 percent spare. The drawings indicate HMI annunciator screen layout and the alarms to be annunciated.

3.1.12.1 Non-critical Alarms

Non-critical alarm windows must be white with black lettering and must sound the panel mounted vibrating horns and the exterior mounted vibrating horns.

3.1.12.2 Critical Alarms

Critical alarm windows must be red with white lettering and must sound the panel mounted vibrating horns and the exterior mounted resonating horns. Critical alarms must also cancel all automatic pump starts in the PLC.

3.1.12.3 Alarm Sequence

Alarm sequence for each alarm must be as follows (ISA 18.1 sequence 'A').

a. For a normal condition, visual indicator and horns will be off.

b. For an alarm condition, visual indicator will flash, and horns will sound (this condition will be locked in).

c. Upon acknowledgment of the alarm condition, visual indicator will be steady on and the horns will be off.

d. If, after acknowledgment of an alarm condition, another alarm condition is established, the new alarm will cause the appropriate

window to flash and the horn to sound.

e. When condition returns to normal after acknowledgment, the visual indicator and the horn will be off.

3.1.13 Human Machine Interface (HMI) Touch Screen

The Human Machine Interface (HMI) Touch Screen must be flush mounted in a wall mounted panel. The Human Machine Interface (HMI) Touch Screen must download system parameters from the PLCs for display. The Human Machine Interface (HMI) Touch Screen must also upload new set point values that the operator has changed using the Human Machine Interface (HMI) Touch Screen, after a password has been entered.

3.1.13.1 Screen Number 1

This must be a general opening screen. As a minimum it must display the name and location of the installation (e.g. Buckley Space Force Base, CO), name of the project (e.g., Power Independence, Mission Control Station) and screen navigation information.

3.1.13.2 Screen Number 2

Screen number two must list the systems parameters monitored by the PCP and their current value. The values must be continuously updated, a 2 second delay maximum between updates will be acceptable.

Parameter	Value
Bulk Receipt Tank	BT-001/BT-002/BT-003/BT-004
Bulk Issue Tank	BT-001/BT-002/BT-003/BT-004
Operating Receipt Tank	OT-N/OT-S
Operating Issue Tank	OT-N/OT-S
OP-1	On/Off xxxxx.xx HOURS
IP-F1	On/Off xxxxx.xx HOURS
IP-F2	On/Off xxxxx.xx HOURS
IP-F3	On/Off xxxxx.xx HOURS
IP-F4	On/Off xxxxx.xx HOURS
IP-O1	On/Off xxxxx.xx HOURS
IP-O2	On/Off xxxxx.xx HOURS
IP-O3	On/Off xxxxx.xx HOURS

IP-O4	On/Off xxxxx.xx HOURS
R10	Open/Closed
R11	Open/Closed
R12	Open/Closed
R13	Open/Closed
R14	Open/Closed
R15	Open/Closed
R16	Open/Closed
R17	Open/Closed
R18	Open/Closed
R19	Open/Closed
R20	Open/Closed
R21	Open/Closed
R27	Open/Closed
R28	Open/Closed
R29	Open/Closed
R30	Open/Closed
R31	Open/Closed
R32	Open/Closed
R33	Open/Closed
R34	Open/Closed
R35	Open/Closed
I01	Open/Closed
I02	Open/Closed
I03	Open/Closed
I04	Open/Closed
I05	Open/Closed
I06	Open/Closed

I07	Open/Closed
I08	Open/Closed
I09	Open/Closed
I10	Open/Closed
I11	Open/Closed
I12	Open/Closed
I13	Open/Closed
I14	Open/Closed
I15	Open/Closed
I16	Open/Closed
I17	Open/Closed
I18	Open/Closed
I19	Open/Closed
I20 (MOV)	Open/Closed
I21 (MOV)	Open/Closed
I22 (MOV)	Open/Closed
I23 (MOV)	Open/Closed
I24	Open/Closed
I25	Open/Closed
I26	Open/Closed
I27	Open/Closed
BV1	Open/Closed
BV2	Open/Closed
BV3	Open/Closed
BV4	Open/Closed
BV5 (MOV)	Open/Closed
BV6 (MOV)	Open/Closed
BV7	Open/Closed

BV8	Open/Closed
BV9 (MOV)	Open/Closed
BV10 (MOV)	Open/Closed
BV11	Open/Closed
BV12	Open/Closed
BV13 (MOV)	Open/Closed
BV14 (MOV)	Open/Closed
BV15	Open/Closed
BV17 (MOV)	Open/Closed
BV18 (MOV)	Open/Closed
BV19	Open/Closed
BV20	Open/Closed
Only one of the words separated by a slash (/) must be displayed. The xxxxx.x HOURS is the fuel pumps elapsed run time and the value must not be lost when the lead PLC is switched. The pump and valve status words must be color coded to match the colors used on the graphic display screen. Manual ball valves and Motor Operated Valves (MOV)s must have different symbols.	

3.1.13.3 Screen Number 3

The following table must be displayed graphically. The table lists the set points that can be adjusted using the operator interface. A password must be entered before the "current value" can be adjusted. The value entered can only be a number within the "set point range". The "default value" is the value held in the program that is loaded into EEPROM memory (This screen may require more than one display screen).

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Bulk Tank No. 1 High-High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 1 High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 1 Pump Stop Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 1 Pump Start Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 1 Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 1 Low-Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 2 High-High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 2 High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 2 Pump Stop Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 2 Pump Start Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 2 Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 2 Low-Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 3 High-High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 3 High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 3 Pump Stop Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 3 Pump Start Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 3 Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 3 Low-Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 4 High-High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 4 High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 4 Pump Stop Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 4 Pump Start Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 4 Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Bulk Tank No. 4 Low-Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 1 High-High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 1 High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Operating Tank No. 1 Pump Start Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 1 Pump Stop Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 1 Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 1 Low-Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 2 High-High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 2 High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 2 Pump Start Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 2 Pump Stop Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 2 Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Operating Tank No. 2 Low-Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 1 High-High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 1 High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 1 Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 1 Low-Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 2 High-High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 2 High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 2 Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 2 Low-Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 3 High-High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 3 High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 3 Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 3 Low-Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 4 High-High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 4 High Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"
Day Tank No. 4 Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Day Tank No. 4 Low-Low Level	xx'-xx" to xx'-xx"	xx'-xx"	xx'-xx"

3.1.13.4 Screen Number 4

This screen must be a duplicate of the Graphic Display Drawing showing a schematic of the process flow. This screen must be referred to as the graphical display. Many operating parameters must be displayed here as required in later paragraphs of this specification.

3.1.13.5 Screen Number 5

This screen must be the Alarm Annunciator and it must be superimposed over the current active screen on the Human Machine Interface (HMI) Touch Screen when an alarm is activated.

3.1.13.6 Screen Number 5

This screen must be a screen designed solely for assisting the testing team during initial start up to watch all of the significant parameters of the systems operation simultaneously on one screen. This screen must include the system parameters i.e. (pump selection, tank selection, valve position, etc.) from screen 2, the set points from screen 3, and timers for all of the actions that will take place following a delay function.

3.1.13.7 Screen Number 7

This screen must be an alarm history screen. This screen must be referred to as the Alarm History Display. This screen must be capable of storing and displaying all alarms that have occurred in the system for at least a period of 30-days.

3.1.13.8 Screen Number 8

This screen must be a screen designed to show EFSO system status. This screen must show the status of all 13 EFSO pushbuttons. Refer to EFSO system control diagram.3.1.14 Laptop Computer

The Laptop computer must be used to create, edit, and load the ladder logic program into the PLCs and the operator interface graphics control program into the Human Machine Interface (HMI) Touch Screen. The Laptop must also be used to monitor the PLCs memory and ladder logic program. The computer must be stored in a lockable cabinet located within the Pump Control Panel.

3.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

3.2.1 General

The basic operation of the PLC system is (Reference "Control System Block Diagram" on the drawings):

a. The CPU and its associated I/O rack (I/O-1) sends system outputs to appropriate devices and receive input signals from field devices (PITs-1, DPTs-1, DPTs-3, flow switches, valve limit switches).

3.2.2 Programs

a. Provide two copies of all working programs (i.e. PLC logic, HMI Touchscreen Terminal) on read only optical discs as well as a printed program listing.

b. Provide rung comments (documentation) in the ladder logic program. Each device, on the ladder, must be identified as to the type of device, i.e. limit switch XX, flow indicator XX, motor starter XX. Rung comments must be provided for input and output rungs. The programmer must also provide a comment describing the function of each rung or group of rungs that accomplish a specific function.

3.3 GRAPHICS DISPLAY SCREEN

3.3.1 General

The graphic display screen shall be capable of being displayed on the Human Machine Interface (HMI) Touch Screen.

3.3.2 Display Presentation

The Graphic Display shall depict the process fuel flow schematically as indicated on the drawings. Red, green, and amber symbols shall be integrated with the process schematic to provide current equipment status graphically. The symbols shall be located immediately adjacent to related equipment symbol.

3.3.3 Process Schematic

The process schematic graphic representation shall utilize conventional symbols when possible. Symbols and flow lines shall be sized and spaced so as to provide a clear representation of the system process. The Graphic Display shall be suitable for supervised field modification when future items are added. Minor changes may be incorporated to allow proper line width and spacing. Component arrangement, piping routing, and location of valves shall match the flow diagram. The Graphic Display layout shall be approved by the Government.

3.4 INSTALLATION

Installation must conform to the manufacturer's drawings, written recommendations and directions.

3.4.1 Shop Drawing

The shop drawing must be clear and readable and preferably drawn using a computer aided drafting package. At the conclusion of the project the

diagram drawings must be redrafted to include all as-built conditions. These updated drawings must be included in the O&M Manuals and appropriate section of the drawings placed in a data pocket located in each of the enclosures. The shop drawing at a minimum must show:

a. Overall dimensions, front, side and interior elevation views of the PCP showing size, location and labeling of each device.

b. Overall dimensions, front elevation of the GDP showing graphical layout and size, location and labeling of each device.

c. Power ladder diagram indicating power connections between SDP, power conditioners, PLCs, power supplies and field and panel devices. Any terminal block connection numbers used must be indicated.

d. Control ladder diagram indicating control connections between field and devices and PLC I/O modules. Terminal block connection numbers and PLC terminal numbers must be indicated.

e. Communication connections between PLCs and I/O racks. Communication channel numbers must be indicated.

f. Bill of materials.

g. Written control sequence covering all inputs, outputs, and control scheme.

3.4.2 System Start-Up and Testing

a. At PCP start-up and testing provide personnel, onsite, to provide technical assistance, program fine tuning, and to start-up and test the system. Start-up and testing must be coordinated with the overall fueling system start-up test specified in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). Prior to this test, all connections must have been made between the PCP, Human Machine Interface (HMI) Touch Screen, and all field devices. In addition, wiring must have been checked for continuity and short circuits. Adjust set point values, timing values, and program logic as required to provide a functional hydrant fuel control system. Once the system has been fine tuned and passed the system test, the new system default values, must be loaded into the PLC EEPROM and Human Machine Interface (HMI) Touch Screen adjusted to indicate the new values.

b. A step-by-step Testing Plan of the PCP must be submitted. The test must be designed to show that every device (lights, switches, display screens, alarms) on the PCP and HMI Touchscreen TerminalHuman Machine Interface (HMI) Touch Screen is in working order and that the PLC program controls the system per specifications. The test must be performed in conjunction with Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). The plan must include a place for the Contractor and government representative to initial each step of the plan after satisfactory completion and acceptance of each step. The complete initialed Record of Test must be certified by the Contractor and then submitted.

3.4.3 Training Plan for Instructing Personnel

a. Upon completion of the system start-up a competent technician regularly employed by the PCP manufacturer must hold a training class

for the instruction of Government personnel in the operation and maintenance of the system. Provide both classroom type theory instruction and hands-on instruction using operating system components provided. The period of instruction must be a minimum of three 8-hour working days. The training must be designed to accommodate 8 operators, 4 maintenance personnel, and 2 programmers. The Contracting Officer must receive written notice a minimum of 14-days prior to the date of the scheduled classes.

b. Furnish a written lesson plan and training schedule for Government approval at least 60-days prior to instructing operating, maintenance and programming personnel. Concurrently submit above to the Service Headquarters or officially designated alternate for their input into the review process. Approval of lesson plan will be based on both Government and Service Headquarters' concurrence. This plan must be tailored to suit the requirements of the Government. The training must be divided into three separate classes. Each class must be tailored to a specific group of personnel. The groups are: 1) Operators, those that will use the control system on a day-to-day basis; 2) Maintenance personnel, those that will perform routine and non-routine maintenance and trouble shooting of the control system; 3) Programmers, those that will make changes to and trouble shoot the PLC and Human Machine Interface (HMI) Touch Screen programs. The training program must provide:

(1) a detailed overview of the control system including the complete step-by-step procedures for start-up, operation and shut-down of the control system.

(2) a general overview of programmable logic controllers.

(3) the maintenance of system components installed.

(4) the programming of the PLC and Human Machine Interface (HMI) Touch Screen.

(5) troubleshooting of the system.

c. Complete approved Operation and Maintenance manuals for this specification and 26 20 00 INTERIOR DISTRIBUTION SYSTEM must be used for instructing operating personnel. Training must include both classroom and hands-on field instruction. The class must be recorded in DVD format.

d. Provide training courses in DVD format covering system overview, operation, maintenance, trouble shooting, and programming. These DVDs must be produced onsite by the Contractor using the supplied Pump Control Panel as the teaching aid, or commercially produced DVDs by the PLC manufacturer or third party who specializes in training on PLC systems. Along with the DVDs, provide workbooks, which follow along with the DVDs.

3.5 PLC CONTROL SYSTEM SEQUENCE OF OPERATION

The following describes general functions of the fueling system components.

3.5.1 Abbreviations

a. SYS: components of System including UPS, power supply, CPU, I/O, and

system input and outputs.

b. CPU: SYS PLC CPU.

c. I/O: SYS PLC input/output modules.

d. PCP: Pump Control Panel.

e. HMI: Human Machine Interface.

f. UPS: Uninterruptible Power Supply.

3.5.2 Bulk Tanks

3.5.2.1 Level Control

Each bulk tank has an Automatic Tank Gauging (ATG) system. The ATG system provides fuel level, volume, temperature and water contents. From the ATG, level control can be generated based on predetermined fuel levels. The ATG must be used to generate low-low, low, high and high-high levels to the PLC system.

3.5.2.1.1 Low-Low Level

When the low-low level is activated, the associated tank's graphic display low-low level symbol must change to red in color. If the selected tank's level drops below the low-low level, the alarm annunciator's low-low level alarm sequence activates, issue pump and MOVs associated with the tank must be disabled. If all tanks are at low-low level, no issue pumps or MOVs in automatic mode must be enabled.

3.5.2.1.2 Low Level

When the low level is activated, the associated tank's graphic display low level symbol must change to red in color and the alarm annunciator's non-critical low level alarm sequence activates.

3.5.2.1.3 High Level

When the high level float is activated the associated tank's graphic display high level light must light up and the alarm annunciator's non-critical high level alarm sequence activates.

3.5.2.1.4 High-High Level

When the high-high level float is activated the associated tank's graphic display high-high level light must light up, the alarm annunciator's critical high-high level alarm sequence activates, the pump control panel must de-energize the solenoid on the tank's high level shutoff valve to force it closed.

3.5.3 Operating Tanks

3.5.3.1 Level Control (ATG)

Each operating tank has an Automatic Tank Gauging (ATG) system and an Independent Level Alarm (ILA) system. The ATG system provides fuel level, volume, temperature and water contents. From the ATG, level control can be generated based on predetermined fuel levels. The ATG must be used to

generate low-low, low, high and high-high levels to the PLC system. The ILA system is used for pump control.

3.5.3.1.1 Low-Low Level

When the low-low level float is activated the associated tank's graphic display low-low level symbol must change to red in color. If the selected tank's level drops below the low-low sensor the alarm annunciator's low-low level alarm sequence activates, issue pump(s) running in automatic mode must be disabled.

3.5.3.1.2 Low Level

When the low level float is activated the associated tank's graphic display low level light must light up and the alarm annunciator's non-critical low level alarm sequence activates.

3.5.3.1.3 High Level

When the high level float is activated the associated tank's graphic display high level light must light up and the alarm annunciator's non-critical high level alarm sequence activates.

3.5.3.1.4 High-High Level

When the high-high level float is activated the associated tank's graphic display high-high level light must light up, the alarm annunciator's critical high-high level alarm sequence activates.

3.5.3.2 Level Control (ILA)

Each operating tank has electronic level switches to monitor low-low, low, high, and high-high fuel levels.

3.5.3.2.1 Low-Low Level

When the low-low level elevation is attained the associated tank's GDP low-low level light must light up. If the selected tank's level drops below the low-low sensor the alarm annunciator's low-low level alarm sequence activates, issue pumps running in automatic mode must be disabled. If all tanks are at low-low level, no issue pumps in automatic mode must be enabled.

3.5.3.2.2 Low Level

When the low level elevation is attained the associated tank's GDP low level light must light up and the alarm annunciator's non-critical low level alarm sequence activates. The low level switch shall start the selected bulk tank issue pump.

3.5.3.2.3 High Level

When the high level elevation is attained the associated tank's GDP high level light must light up and the alarm annunciator's non-critical high level alarm sequence activates. The high level switch shall shut off the selected bulk tank issue pump.

3.5.3.2.4 High-High Level

When the high-high level elevation is attained, the associated tank's GDP high-high level light must light up and the alarm annunciator's critical high-high level alarm sequence activates. The High-high level switch closes the associated operating tank MOV.

3.5.4 Day Tanks

3.5.4.1 Level Control (ATG)

Each day tank has four level float switches to measure low-low, low, high and high-high levels.

3.5.4.1.1 Low-Low Level

When the low-low level float is activated the associated tank's graphic display low-low level symbol must change to red in color. If the selected tank's level drops below the low-low sensor the alarm annunciator's low-low level alarm sequence activates, issue pump(s) running in automatic mode must be disabled.

3.5.4.1.2 Low Level

When the low level float is activated the associated tank's graphic display low level light must light up and the alarm annunciator's non-critical low level alarm sequence activates.

3.5.4.1.3 High Level

When the high level float is activated the associated tank's graphic display high level light must light up and the alarm annunciator's non-critical high level alarm sequence activates.

3.5.4.1.4 High-High Level

When the high-high level float is activated the associated tank's graphic display high-high level light must light up, the alarm annunciator's critical high-high level alarm sequence activates.

3.5.4.2 Level Control (ILA)

Each day tank has electrinic level switches to monitor low-low, low, high, and high-high fuel levels.

3.5.4.2.1 Low-Low Level

When the low-low level elevation is attained the associated tank's GDP low-low level light must light up. If the selected tank's level drops below the low-low sensor the alarm annunciator's low-low level alarm sequence activates, the associated generator shall not start.

3.5.4.2.2 Low Level

When the low level elevation is attained the associated tank's GDP low level light must light up and the alarm annunciator's non-critical low level alarm sequence activates. The selected operating tank lead pump shall start.

3.5.4.2.3 High Level

When the high level elevation is attained the associated tank's GDP high level light must light up and the alarm annunciator's non-critical high level alarm sequence activates. The operating tank lead pump shall stop.

3.5.4.2.4 High-High Level

When the high-high level elevation is attained, the associated tank's GDP high-high level light must light up and the alarm annunciator's critical high-high level alarm sequence activates.

3.5.5 Fueling Pumps (FP)

The lead pump selection must select the pump starting sequence. Each pump's motor controller has a status relay to indicate the on/off status of the pump. When status relay is open the associated pump's graphic display off light must activate and screen number 2 must indicate on. When the status relay is closed the associated pump's graphic display on light must activate and screen number 2 must indicate off. The status relay state must also be used to start and stop the pumps elapsed run time timer and must be displayed on screen number 2.

3.5.6 Flow Switch, Fueling Pump

On the discharge side of each pump is a flow switch to indicate positive flow (fail safe feature). If the PLC has given a signal to start a pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running then the pump must be in a failure state and it must be disabled (taken out of the starting sequence), the non-critical alarm sequence must also be activated, and the next pump in the start sequence started. After the PLC has stopped all of the pumps, any failed pump must be added back into the start sequence.

3.5.7 Safety Circuit

3.5.7.1 Emergency Stop Status

The emergency stop circuit status relay (ER1) N.O. contact must be connected as indicated on the Terminal Block Connection drawing. When the circuit is activated the critical alarm sequence is activated and any calls to start fueling pumps must be canceled and no additional pump start signals must be sent until the circuit has been reset. The fueling pumps will actually be stopped by an emergency stop circuit status relay (ER1) N.O. contact in the fuel pump motor control circuit.

3.5.7.2 Circuit Power Status

When the safety circuit power status relay is closed the PCP emergency circuit power on light must light up.

3.5.8 Pump Control Panel

3.5.8.1 CPU Faults

The PCP mounted CPU on light is connected to SYS. The associated CPU light must light when no system faults are detected. When a fault is detected by the CPU the faulted CPU's on light must be turned off and the alarm

annunciator's non-critical alarm sequence must be activated.

3.5.8.2 Mode Select

The HMI touch screen shows what mode of fueling is active: issue, or off. The screen number 2 status must indicate the active mode.

A selection on the The HMI touch screen selects what mode of fueling is active: issue, transfer or off. The screen number 2 status must indicate the active mode.

A selection on the The HMI touch screen selects what mode of fueling is active: issue, transfer, tightness Test or off. The screen number 2 status must indicate the active mode.

3.5.8.3 Lead Pump Select (Operating Tanks)

A selection on the The HMI touch screen selects which pump must be the lead pump. The selection must fix the starting sequence for all pumps. If the lead pump fails to start or fails during operation, that pump will be disabled and the lag pump in the sequence started. The screen number 2 status display must indicate the lead pump.

3.5.8.4 PCP Temperature Alarm

The alarm thermostat when activated must activate the alarm annunciator's non-critical alarm sequence.

3.6 OPERATING PROGRAM REQUIREMENTS

The control system's logic program must be stored on a EEPROM chip. Default values of operator adjustable parameters must be permanently stored on the chip with the capability of resetting the values in RAM to the values within the range specified below. The default values can be changed through the use of the personal computer (after the correct password has been entered). After loss of power and battery failure the adjustable settings must revert back to the default values located on the chip. The default values shown here must be reset to the values determined during the system start up and test.

3.7 AUTOMATIC MODE - TRANSFER CONDITION

a. The issue bulk tank pump shall start when the operating tank ILA low level switch is closed. The issue bulk tank pump shall stop when the operating tank ILA high level switch is closed. If the issue bulk tank ATG low-low level alarm is activated, the bulk tank issue pump shall not start.

b. The operating tank lead issue pump shall start when a day tank ILA low level switch is closed. The operating tank lead pump shall stop when the day tank ILA high level switch is closed. MOVs BV06, BV10, BV14, and BV18 on the primary issue fuel line shall be commanded open. MOVs BV05, BV09, BV13, and BV17 on the secondary issue fuel line shall be commanded closed. If the day tank ATG low-low level alarm is activated the associated generator shall not start.

c. Any failure of an operational tank lead pump shall automatically start the operational tank lag pump. MOVs BV05, BV09, BV13, and BV17 on the secondary issue fuel line shall be commanded open. MOVs BV06, BV10,

BV14, and BV18 on the primary issue fuel line shall be commanded closed.

d. Any MOV position error such as an MOV on the primary issue fuel line fails to open, the operating tank lead pump shall automatically stop and the operating tank lag pump shall automatically start. Starting of the operating tank lag pump commands MOVs BV05, BV09, BV13, and BV17 on the secondary issue fuel line to open. MOVs BV06, BV10, BV14, and BV18 on the primary issue fuel line shall be commanded closed isolating the failure on the primary fuel line.

3.8 OFF MODE

a. Automatic starting of fueling pumps must be disabled. All other functions (graphic display, HMI touchscreen terminal, EFSO system) must be active to allow manual control of the fueling pumps using the Hand-Off-Auto or Hand-Auto switch.

b. The second, fueling pumps maybe started or stopped manually as needed by the operator.

3.9 MANUAL OPERATION OF FUELING PUMPS

a. If the PLC system is still active see paragraph OFF MODE.

b. If the PLC system has no power or the CPUs have faulted (CPU light on PCP off) the pumping system will be in a completely manual mode. Other valves may need to be opened or closed manually by the operators for the system to work properly.

-- End of Section --

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SECTION 33 11 00

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SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.26	(2018) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.5.2.1M	(2006; R 2011) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2010) Metric Round Head Square Neck Bolts

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2018) Hypochlorites
AWWA B301	(2018) Liquid Chlorine
AWWA C104/A21.4	(2022) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2023) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C153/A21.53	(2019) Ductile-Iron Compact Fittings for Water Service
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C502	(2018) Dry-Barrel Fire Hydrants
AWWA C509	(2015) Resilient-Seated Gate Valves for Water Supply Service

AWWA C515	(2015) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C550	(2017) Protective Interior Coatings for Valves and Hydrants
AWWA C600	(2017) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C604	(2011) Installation of Buried Steel Water Pipe—4 In. (100 mm) and Larger
AWWA C605	(2021) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C651	(2014) Standard for Disinfecting Water Mains
AWWA C655	(2009) Field Dechlorination
AWWA C800	(2014) Underground Service Line Valves and Fittings
AWWA C900	(2022) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA M9	(2008; Errata 2013) Manual: Concrete Pressure Pipe
AWWA M11	(2016) Steel Pipe: A Guide for Design and Installation
AWWA M23	(2002; 2nd Ed) Manual: PVC Pipe - Design and Installation
AWWA M55	(2006) PE Pipe - Design and Installation

ASTM INTERNATIONAL (ASTM)

ASTM A47/A47M	(1999; R 2022; E 2022) Standard Specification for Ferritic Malleable Iron Castings
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM B32	(2020) Standard Specification for Solder Metal

ASTM B61	(2015) Standard Specification for Steam or Valve Bronze Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2241	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2467	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2774	(2012) Underground Installation of Thermoplastic Pressure Piping
ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F402	(2005; R 2012) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F1674	(2018) Standard Test Method for Joint Restraint Products for Use with PVC Pipe
ASTM F1962	(2011) Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings
ASTM F2164	(2018) Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances

NSF INTERNATIONAL (NSF)

NSF 372	(2016) Drinking Water System Components - Lead Content
NSF/ANSI 14	(2023) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2022) Drinking Water System Components - Health Effects

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-600-01	(2016; with Change 6, 2021) Fire Protection Engineering for Facilities

UL SOLUTIONS (UL)

UL 246	(2011; Reprint Dec 2018) UL Standard for Safety Hydrants for Fire-Protection Service
UL 262	(2004; Reprint Jul 2023) Gate Valves for Fire-Protection Service

1.2 DEFINITIONS

1.2.1 Water Mains

Water mains include water piping having diameters 4 through 14 inch, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.2.2 Water Service Lines

Water service lines include water piping from a water main to a building service at a point approximately 5 feet from building or the point indicated on the drawings, specific materials, methods of joining and any appurtenances deemed necessary for a satisfactory system.

1.2.3 Additional Definitions

For additional definitions refer to the definitions in the applicable referenced standard.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Connections; G-RO

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1.4 QUALITY CONTROL

1.4.1 Regulatory Requirements

Comply with NSF/ANSI 14 or NSF/ANSI 61 and NSF 372 for materials for potable water systems; comply with lead content requirements for "lead-free" plumbing as defined by the U.S. Safe Drinking Water Act effective January 2014. Provide materials bearing the seal of the National Sanitation Foundation (NSF) for potable water service.

Comply with NFPA 24 for materials, installation, and testing of fire main piping and components.

1.4.2 Qualifications

1.4.2.1 Fusion Technician Qualifications

Submit a certificate from the manufacturer of the fusible pipe that shows the fusion technician is fully qualified to install fusible pipe of the types and sizes being used. Qualification must be current as of the actual date of fusion performance on the project.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling and in accordance with manufacturer's instructions. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, and other accessories free of dirt and debris.

1.5.2 Handling

Handle pipe, fittings, valves, and other accessories in accordance with manufacturer's instructions and in a manner to ensure delivery to the trench in sound undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place other material, hooks, or pipe inside a pipe or fitting after the coating has been applied. Inspect the pipe for defects before installation. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. Clean the interior of pipe and accessories of foreign matter before being lowered into the trench and keep them clean during laying operations by plugging. Replace defective material without additional expense to the Government. Store rubber gaskets, not immediately installed, under cover or out of direct sunlight.

Handle PVC and PVCO pipe, fittings, and accessories in accordance with AWWA C605. Handle PE pipe, fittings, and accessories in accordance with AWWA M55. Handle steel pipe, fittings and accessories in accordance with AWWA C604.

PART 2 PRODUCTS

2.1 MATERIALS

Provide all materials in accordance with AWWA C800 and as indicated herein. Provide valves and fittings with pressure ratings equivalent to the pressure ratings of the pipe.

2.1.1 Pipe, Fittings, Joints And Couplings

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.

2.1.1.1 Plastic Piping

2.1.1.1.1 PVC Piping

2.1.1.1.1.1 PVC Piping

AWWA C900 plain end or gasket bell end pipe meeting or exceeding ASTM D1784 cell class 12454, with a minimum Pressure Class 150 (DR27.5), , , , with ductile iron outside diameter (DIOD).

2.1.1.1.1.2 Fittings for PVC Pipe

Gray iron or ductile iron fittings, AWWA C110/A21.10 with special fittings in accordance with Appendix B or AWWA C153/A21.53, with cement-mortar lining for fittings, AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends are to conform to the same requirements as fittings with mechanical-joint ends, except for the factory modified bell design compatible for use with PVC pipe as specified.

2.1.1.1.1.3 Joints and Jointing Material for PVC

a. Push-on joints: Use jointing material in accordance with ASTM D3139 and AWWA C111/A21.11 between pipes, pipes and metal fittings, valves, and other accessories or compression-type joints/mechanical joints. Provide each joint connection with an elastomeric gasket compatible for the bell or coupling used. Gaskets for push-on joints for pipe, ASTM F477. Gaskets for push-on joints and compression-type joints/mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories, AWWA C111/A21.11, respectively, for push-on joints and mechanical joints.

b. Mechanical Joint: Use mechanically coupled joints having a sleeve-type mechanical coupling, as specified in the paragraph SLEEVE-TYPE MECHANICAL COUPLINGS, as an optional jointing method for plain-end PVC pipe, subject to the limitations specified for mechanically coupled joints using a sleeve-type mechanical coupling as specified for compression-type joints in ASTM D3139. Provide jointing material in accordance with AWWA C111/A21.11 between pipe and sleeve-type mechanical couplings.

2.1.1.1.2 PVC Piping for Service Lines

2.1.1.1.2.1 Pipe and Fittings

Provide ASTM D1784 cell class 12454 pipe and fittings of the same PVC material.

a. ASTM D2467 Schedule 80 fittings.

b. ASTM D2241 pipe and fittings with SDR as necessary to provide 150 psi minimum pressure rating with ASTM D2467 Schedule 80 fittings.

2.1.1.1.2.2 Joints and Connections

Fittings may be joined by the solvent-cement method or threading.

2.1.1.1.2.3 Solvent Joining

Provide solvent joints in accordance with ASTM D2855.

2.1.2 Valves

Provide a protective interior coating in accordance with AWWA C550.

2.1.2.1 Gate Valves 3 Inch Size and Larger

AWWA C500, AWWA C509, AWWA C515, or UL 262 and:

a. AWWA C500: outside-screw-and-yoke rising-stem type with double-disc gates and flanged ends

b. AWWA C509 or AWWA C515: outside-screw-and-yoke rising-stem type with flanged ends

c. UL 262: outside-screw-and-yoke type, with double-disc or split-wedge type gate and flanged ends, and designed for a hydraulic working pressure of 175 psi

Match materials for UL 262 gate valves to the reference standards specified in AWWA C500. Provide gate valves with handwheels that open by counterclockwise rotation of the valve stem. Bolt and construct stuffing boxes so as to permit easy removal of parts for repair. In lieu of flanged ends, provide valves with grooved ends compatible with grooved type joints, as specified in the paragraph DUCTILE-IRON PIPING. Provide all valves from one manufacturer.

2.1.2.2 Water Service Valves

2.1.2.2.1 Gate Valves Smaller than 3 Inch in Size on Buried Piping

Gate valves smaller than 3 inch size MSS SP-80, Class 150, solid wedge, nonrising stem, with flanged or threaded end connections, a union on one side of the valve, and a handwheel operator.

2.1.2.2.2 Gate Valves Smaller Than 3 Inch Size in Valve Pits

MSS SP-80, Class 150, solid wedge, inside screw, rising stem. Provide valves with flanged or threaded end connections, a union on one side of the valve, and a handwheel operator.

2.1.3 Blowoff Valve Assemblies

Provide blowoff valve assemblies complete with all pipe, fittings, valve, valve box, riser box and lid, riser extension, discharge fitting and other materials required to connect to the water main. Provide blow off valve assemblies 4 inches or larger with AWWA C110/A21.10 or AWWA C153/A21.53 fittings.

2.1.4 Fire Hydrants

2.1.4.1 Fire Hydrants

Provide fire hydrants where indicated. Paint fire hydrants with at least one coat of primer and two coats of enamel paint. Paint barrel and bonnet colors in accordance with UFC 3-600-01. Stencil fire hydrant number and main size on the fire hydrant barrel using black stencil paint.

2.1.4.1.1 Fire Hydrants

Provide Dry-barrel type fire hydrants, AWWA C502 or UL 246, "Base Valve" with 6 inch inlet, 5 1/4 inch valve opening, one 4 1/2 inch pumper connection, and two 2 1/2 inch hose connections.

Provide mechanical-joint end only inlet , except where flanged end is indicated; with end matching requirements as specified in AWWA C502 or UL 246 for size and shape of operating nut, cap nuts, and threads on hose and pumper connections. Provide fire hydrants with . Provide fire hydrant with special couplings joining that break from a force imposed by a moving vehicle.

2.1.5 Disinfection

Chlorinating materials are to conform to: Chlorine, Liquid: AWWA B301; Hypochlorite, Calcium and Sodium: AWWA B300.

2.2 ACCESSORIES

2.2.1 Pipe Restraint

2.2.1.1 Thrust Blocks

Use ASTM C94/C94M concrete having a minimum compressive strength of 2,500 psi at 28 days or use concrete of a mix not leaner than one part cement, two and one half parts sand, and five parts gravel, having the same minimum compressive strength.

2.2.1.2 Precast Thrust Blocks

Provide precast concrete thrust blocks.

2.2.1.3 Joint Restraint

Provide restrained joints in accordance with NFPA 24, Chapter 10.

Provide mechanical joint restraint .

2.2.2 Tapping Sleeves

Provide cast gray, ductile, malleable iron or stainless steel, split-sleeve type tapping sleeves of the sizes indicated for connection to existing main with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Utilize similar metals for bolts, nuts, and washers to minimize the possibility of galvanic corrosion. Provide dielectric gaskets where dissimilar metals adjoin. Provide a tapping sleeve assembly with a maximum working pressure of 150 psi. Provide bolts with square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, utilize an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pre-torqued to 50 foot-pound.

2.2.3 Sleeve-Type Mechanical Couplings

Use couplings to join plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling consists of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. Provide true circular middle ring and the follower rings sections free from irregularities, flat spots, and surface defects; provide for confinement and compression of the gaskets. For ductile iron and PVC pipe, the middle ring is cast-iron . Malleable and ductile iron are to meet the requirements of ASTM A47/A47M and ASTM A536, respectively. Use gaskets for resistance to set after installation and to meet the requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Provide track-head type bolts ASTM A307, Grade A, with nuts, ASTM A563, Grade A; or round-head square-neck type bolts, ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts, ASME B18.2.2. Provide 5/8 inch diameter bolts; minimum number of bolts for each coupling is 3 for 3 inch pipe, 5 for 6 inch pipe, and 6 for 8 inch pipe. Shape bolt holes in follower rings to hold fast to the necks of the bolts used. Do not use mechanically coupled joints using a sleeve-type mechanical coupling as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint. Provide a tight flexible joint with mechanical couplings under reasonable conditions, such as pipe movements caused by expansion, contraction, slight settling or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Match coupling strength to that of the adjoining pipeline.

2.2.4 Insulating Joints

Provide a rubber-gasketed insulating joint or dielectric coupling between pipe of dissimilar metals which will effectively prevent metal-to-metal contact between adjacent sections of piping.

2.2.5 Bonded Joints

For all ferrous pipe, provide a metallic bond at each joint, including joints made with flexible couplings, caulking, or rubber gaskets, of ferrous metallic piping to effect continuous conductivity. Provide Size 1/0 copper conductor thermal weld type bond wire designed for direct burial and shaped to stand clear of the joint.

2.2.6 Dielectric Fittings

Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains to prevent metal-to-metal contact of dissimilar metallic piping elements and compatible with the indicated working pressure.

2.2.7 Tracer Wire for Nonmetallic Piping

Provide a continuous bare copper or aluminum wire not less than 0.10 inch in diameter in sufficient length over each separate run of nonmetallic pipe.

2.2.8 Water Service Line Appurtenances

2.2.8.1 Corporation Stops

Ground key type; lead-free bronze, ASTM B61 or ASTM B62; compatible with the working pressure of the system and solder-joint, or flared tube compression type joint. Threaded ends for inlet and outlet of corporation stops, AWWA C800; coupling nut for connection to flared copper tubing, ASME B16.26.

2.2.8.2 Curb or Service Stops

Ground key, round way, inverted key type; made of lead-free bronze, ASTM B61or ASTM B62; and compatible with the working pressure of the system. Provide compatible ends for connection to the service piping. Cast an arrow into body of the curb or service stop indicating direction of flow.

2.2.8.3 Service Clamps

Provide single or double flattened strap type service clamps used for repairing damaged cast-iron, steel or PVC pipe with a pressure rating not less than that of the pipe being repaired. Provide clamps with a galvanized malleable-iron body with cadmium plated straps and nuts and a rubber gasket cemented to the body.

2.2.8.4 Curb Boxes

Provide a curb box for each curb or service stop manufactured from cast iron, size capable of containing the stop where it is used. Provide a round head. Cast the word "WATER" on the lid. Factory coat the box with a heavy coat of bituminous paint.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Connections to Existing System

Perform all connections to the existing water system in the presence of the Contracting Officer.

3.1.2 Operation of Existing Valves

Do not operate valves within or directly connected to the existing water system unless expressly directed to do so by the Contracting Officer.

3.1.3 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.2 INSTALLATION

Install all materials in accordance with the applicable reference standard, manufacturers instructions and as indicated herein.

3.2.1 Piping

3.2.1.1 General Requirements

Install pipe, fittings, joints and couplings in accordance with the applicable referenced standard, the manufacturer's instructions and as specified herein.

3.2.1.1.1 Termination of Water Lines

Terminate the work covered by this section at a point approximately 5 feet from the building, unless otherwise indicated.

Do not lay water lines in the same trench with gas lines, fuel lines, electric wiring, or any other utility. Do not install copper tubing in the same trench with ferrous piping materials. Where nonferrous metallic pipe (i.e., copper tubing) crosses any ferrous piping, provide a minimum vertical separation of 12 inches between pipes.

3.2.1.1.2 Pipe Laying and Jointing

Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Under no circumstances is it permissible to drop or dump pipe, fittings, valves, or other water line material into trenches. Cut pipe cleanly, squarely, and accurately to the length established at the site and work into place without springing or forcing. Replace a pipe or fitting that does not allow sufficient space for installation of jointing material. Blocking or wedging between bells and spigots is not permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at the design elevation and grade. Secure firm, uniform support. Wood support blocking is not permitted. Lay pipe so that the full length of each section of pipe and each fitting rests solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports for fastening work into place. Make provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been assembled. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation. Provide a minimum of 2 1/2 feet depth of cover over top of pipe.

3.2.1.1.3 Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

3.2.1.1.4 Connections to Existing Water Lines

Make connections to existing water lines after coordination with the facility and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped and as indicated, except as otherwise specified, tap concrete pipe in accordance with AWWA M9 for tapping concrete pressure pipe.

3.2.1.1.5 Sewer Manholes

No water piping is to pass through or come in contact with any part of a sewer manhole.

3.2.1.1.6 Water Piping Parallel With Sewer Piping

Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer than 10 feet, horizontally, from any sewer line.

3.2.1.1.7 Water Piping Crossing Sewer Piping

Provide at least 18 inches above the top (crown) of the sewer piping and the bottom (invert) of the water piping whenever possible. Measure the distance edge-to-edge. Where water lines cross under gravity sewer lines, construct sewer line of AWWA compliant ductile iron water piping with rubber-gasketed joints and no joint located within 10 feet, horizontally, of the crossing.

3.2.1.1.8 Penetrations

Provide ductile-iron or Schedule 40 steel wall sleeves for pipe passing through walls of valve pits and structures. Fill annular space between walls and sleeves with rich cement mortar. Fill annular space between pipe and sleeves with mastic.

3.2.1.2 PVC Water Main Pipe

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, setting of fire hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

a. Jointing: Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use a lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with

sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.

b. Joint Offset: Construct joint offset in accordance AWWA C605. Do not exceed the minimum longitudinal bending as indicated by AWWA C605.

c. Fittings: Install in accordance with AWWA C605.

3.2.1.3 Metallic Piping for Service Lines

Install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the applicable requirements of AWWA C600 for pipe installation, unless otherwise specified.

3.2.1.3.1 Screwed Joints

Make screwed joints up tight with a stiff mixture of graphite and oil, inert filler and oil, or graphite compound; apply to male threads only or with PTFE Tape, for use with threaded pipe. Threads are to be full cut; do not leave more than three threads on the pipe exposed after assembling the joint.

3.2.1.3.2 Joints for Copper Tubing

Cut copper tubing with square ends; remove fins and burrs. Replace dented, gouged, or otherwise damaged tubing with undamaged tubing. Make solder joints using ASTM B32, 95-5 tin-antimony or Grade Sn96 solder. Use solder and flux containing less than 0.2 percent lead. Before making joint, clean ends of tubing and inside of fitting or coupling with wire brush or abrasive. Apply a rosin flux to the tubing end and on recess inside of fitting or coupling. Insert tubing end into fitting or coupling for the full depth of the recess and solder. For compression joints on flared tubing, insert tubing through the coupling nut and flare tubing.

3.2.1.3.3 Protection of Buried Steel Service Line Piping

Unless otherwise specified, prepare, prime, and coat exterior surface of zinc-coated steel pipe and associated fittings to be buried with hot-applied coal-tar enamel with a bonded single layer of felt wrap in accordance with AWWA C203. For the felt wrap material, use fibrous-glass mat as specified in AWWA C203; use of asbestos felt will not be permitted. Use solvent wash only to remove oil, grease, and other extraneous matter from zinc-coated pipe and fittings.

3.2.1.4 Plastic Service Piping

Install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS and with the applicable requirements of ASTM D2774 , unless otherwise specified. Handle solvent cements used to join plastic piping in accordance with ASTM F402.

3.2.1.4.1 Jointing

Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.2.1.4.2 Plastic Pipe Connections to Appurtenances

Connect plastic service lines to corporation stops and gate valves in accordance with the recommendations of the plastic pipe manufacturer.

3.2.1.5 Trenchless Piping

3.2.1.5.1 Butt Fusion

Fusible pipe will be fused by qualified fusion technicians, as required by manufacturer of the fusion equipment. Record and log each fusion joint by an electronic monitoring device (data logger) connected to the fusion machine. Log fusion data and create Post-Construction Fusion Report with software specifically developed for the pipe material being fused. Software must record the parameters required by the fusion equipment manufacturer and these specifications. Manual log data not logged by the data logger and be included in the Post-Construction Fusion Report. Assemble fusible PVC and PE pipe lengths in the field with butt-fused joints. Follow the manufacturer's fusion equipment procedures.

a. Install butt fused PE Pipe in accordance with ASTM F1962.

b. For butt fused PVC Pipe provide joints meeting the requirements of ASTM F1674.

3.2.1.5.2 Post-Construction Fusion Report

Include the following data for each fusible connection in the report:

a. Pipe Size and Thickness
b. Machine Size
c. Fusion Technician Identification
d. Job Identification
e. Fusion Joint Number
f. Fusion, Heating, and Drag Pressure Settings
g. Heat Plate Temperature
h. Time Stamp
i. Heating and Cool Down Time of Fusion
j. Ambient Temperature

3.2.1.6 Fire Protection Service Lines for Sprinkler Supplies

Connect water service lines used to supply building sprinkler systems for fire protection to the water main in accordance with NFPA 24.

3.2.1.7 Water Service Piping

3.2.1.7.1 Location

Connect water service piping to the building service where the building service has been installed. Where building service has not been installed, terminate water service lines approximately 5 feet from the building line at the points indicated; close such water service lines with plugs or caps.

3.2.1.7.2 Water Service Line Connections to Water Mains

Connect water service lines to the main by a corporation stop . Connect water service lines to steel water mains in accordance with the

recommendations of the steel water main pipe manufacturer and with the recommendations for special and valve connections and other appurtenances in AWWA M11, Chapter 13, "Supplementary Design Data and Details."

3.2.2 Disinfection

Prior to disinfection, provide disinfection procedures, proposed neutralization and disposal methods of waste water from disinfection as part of the disinfection submittal. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. Disinfect new water piping using the AWWA C651 continuous-feed method of chlorination. Ensure a free chlorine residual of not less than 10 parts per million after 24 hour holding period and prior to performing bacteriological tests.

3.2.3 Flushing

Perform bacteriological tests prior to flushing. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 to 0.5 parts per million, the residual chlorine content of the distribution system, or acceptable for domestic use. Use AWWA C655 neutralizing chemicals.

3.2.4 Pipe Restraint

3.2.4.1 Concrete Thrust Blocks

Install concrete thrust blocks where indicated.

3.2.4.2 Restrained Joints

Install restrained joints in accordance with the manufacturer's instructions where indicated.

3.2.5 Valves

3.2.5.1 Gate Valves

Install gate valves, AWWA C500 and UL 262, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C500. Install gate valves, AWWA C509 or AWWA C515, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509 or AWWA C515. Install gate valves on PVC water mains in accordance with the recommendations for appurtenance installation in AWWA M23, Chapter 7, "Installation." Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.

3.2.5.2 Air Release, Air/Vacuum, and Combination Air Valves

Install pressure vacuum assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to the requirements of plumbing and health department and authorities having jurisdiction. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

3.2.6 Fire Hydrants

Install fire hydrants in accordance with AWWA C600 for fire hydrant installation and as indicated. Make and assemble joints as specified for making and assembling the same type joints between pipe and fittings. Install fire hydrants with the 4 1/2 inch connections facing the adjacent paved surface. If there are two paved adjacent surfaces, install fire hydrants with the 4 1/2 inch connection facing the paved surface where the connecting main is located.

3.3 FIELD QUALITY CONTROL

3.3.1 Tests

Notify the Contracting Officer a minimum of five days in advance of hydrostatic testing. Coordinate the proposed method for disposal of waste water from hydrostatic testing. Perform field tests, and provide labor, equipment, and incidentals required for testing. Provide documentation that all items of work have been constructed in accordance with the Contract documents.

3.3.1.1 Hydrostatic Test

Test the water system in accordance with the applicable AWWA standard specified below. Test PVCplastic water systems made with PVC pipe in accordance with the requirements of AWWA C605 for pressure and leakage tests. The amount of leakage on pipelines made of PVC water main pipe is not to exceed the amounts given in AWWA C605, except that at joints made with sleeve-type mechanical couplings, no leakage will be allowed. Test concrete water mains in accordance with the recommendations in AWWA M9, "Hydrostatic Testing and Disinfection of Mains." The amount of leakage on concrete pipelines is not to exceed 20 gallons per 24 hours per inch of pipe diameter per mile of pipeline. Test steel water mains in accordance with applicable requirements of AWWA C600 for hydrostatic testing. The amount of leakage on steel pipelines with rubber-gasketed bell-and-spigot joints is not to exceed 20 gallons per 24 hours per inch of pipe diameter per mile of pipeline; no leakage will be allowed at joints made by any other method. To stop leakage, repair welded joints only by welding. Test water service lines in accordance with requirements of AWWA C600 for hydrostatic testing. No leakage will be allowed at copper pipe joints, copper tubing joints (soldered, compression type, brazed), plastic pipe joints, and screwed joints. Do not backfill utility trench or begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least 7 days after placing of the concrete.

3.3.1.2 Leakage Test

For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

For PE perform leak testing in accordance with ASTM F2164.

3.3.1.3 Bacteriological Testing

Perform bacteriological tests in accordance with AWWA C651 . Analyze samples by a certified laboratory, and submit the results of the bacteriological samples.

3.3.1.4 Special Testing Requirements for Fire Service

Test water mains and water service lines providing fire service or water and fire service in accordance with NFPA 24. The additional water added to the system must not exceed the limits given in NFPA 24

3.3.1.5 Tracer Wire Continuity Test

Test tracer wire for continuity after service connections have been completed and prior to final pavement or restoration. Verify that tracer wire is locatable with electronic utility locating equipment. Repair breaks or separations and re-test for continuity.

3.4 SYSTEM STARTUP

Water mains and appurtenances must be completely installed, disinfected, flushed, and satisfactory bacteriological sample results received prior to permanent connections being made to the active distribution system. Obtain approval by the Contracting Officer prior to the new water piping being placed into service.

3.5 CLEANUP

Upon completion of the installation of water lines and appurtenances, remove all debris and surplus materials resulting from the work.

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05/18

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SECTION 33 30 00

SANITARY SEWERAGE
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM C33/C33M	(2023) Standard Specification for Concrete Aggregates
ASTM C94/C94M	(2024c) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C270	(2019a; E 2019) Standard Specification for Mortar for Unit Masonry
ASTM C443	(2021) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C478M	(2018) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C923	(2008; R 2013; E 2016) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C972	(2000; R 2011) Compression-Recovery of Tape Sealant

ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C1244	(2020) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2412	(2021) Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	(2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F949	(2020) Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.27	(Nov 2016) Scaffolds and Roope Descent Systems

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.2 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. When used, a code following the "G" classification

identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's License; G-RO

SD-02 Shop Drawings

Installation Drawings; G-RO

SD-03 Product Data

Precast Concrete Manholes; G-RO

Frames, Covers, and Gratings; G-RO

SD-06 Test Reports

Precast Concrete Sewer Manhole Test; G-RO

Hydrostatic Sewer Test; G-RO

Negative Air Pressure Test; G-RO

Low-Pressure Air Tests; G-RO

Deflection Testing; G-RO

SD-07 Certificates

Portland Cement

Pre-Installation Inspection Request; G-RO

Post-Installation Inspection Request; G-RO

1.3 QUALITY CONTROL

1.3.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Verify installing Contractor's License is current and state certified or state registered.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

1.4.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of

handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.4.1.2 Cement, Aggregate, and Reinforcement

As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.4.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe in accordance with the manufacturer's recommendation and discard those materials if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Sanitary Sewer Gravity Pipeline

Provide mains and laterals lines of polyvinyl chloride (PVC) plastic pipe. Provide building connections of polyvinyl chloride (PVC) plastic pipe. Provide new and modify existing exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls.

2.2 MATERIALS

Provide materials conforming to the respective specifications and other requirements specified below. Submit manufacturer's product specification,standard drawings or catalog cuts.

2.2.1 PVC Gravity Sewer Piping

2.2.1.1 PVC Gravity Pipe and Fittings

ASTM D3034, SDR 35, or ASTM F949 with ends suitable for elastomeric gasket joints.

2.2.1.2 PVC Gravity Joints and Jointing Material

Provide joints conforming to ASTM D3212. Gaskets are to conform to ASTM F477.

2.2.2 Cement Mortar

Provide cement mortar conforming to ASTM C270, Type M with Type II cement.

2.2.3 Portland Cement

Submit certificates of compliance stating the type of cement used in manufacture of precast manholes. Provide portland cement conforming to ASTM C150/C150M, Type II for concrete used in concrete pipe, concrete pipe fittings, septic tanks, and manholes and type optional for cement used in concrete cradle, concrete encasement, and thrust blocking. Use a cement containing less than 0.60 percent alkalies where aggregates are alkali reactive, as determined by Appendix XI of ASTM C33/C33M.

2.2.4 Portland Cement Concrete

Provide portland cement concrete conforming to ASTM C94/C94M, compressive strength of 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement is to have a compressive strength of 2500 psi minimum at 28 days. Protect concrete in place from freezing and moisture loss for 7 days.

2.2.5 Precast Concrete Manholes

Provide precast concrete manholes, risers, base sections, and tops conforming to ASTM C478.

2.2.6 Gaskets and Connectors

Provide gaskets for joints between manhole sections conforming to ASTM C443. Resilient connectors for making joints between manhole and pipes entering manhole are to conform to ASTM C923 or ASTM C990.

2.2.7 External Preformed Rubber Joint Seals

An external preformed rubber joint seal is an accepted method of sealing cast iron covers to precast concrete sections to prevent ground water infiltration into sewer systems. All finished and sealed manholes constructed in accordance with paragraph entitled "Manhole Construction" are to be tested for leakage in the same manner as pipelines as described in paragraph entitled "Leakage Tests." The seal is to be multi-section with a neoprene rubber top section and all lower sections made of Ethylene Propylene Diene Monomer (EPDM) rubber with a minimum thickness of 60 mils. Each unit is to consist of a top and bottom section and have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic is to be a non-hardening butyl rubber sealant and seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. Extension sections are to cover up to two more adjusting rings. Properties and values are listed in the following table:

Properties, Test Methods and Minimum Values for Rubber used in Preformed Joint Seals

Physical Properties	Test Methods	EPDM	Neoprene	Butyl Mastic
Tensile, psi	ASTM D412	1840	2195	--
Elongation, percent	ASTM D412	553	295	350

Properties, Test Methods and Minimum Values for Rubber used in Preformed Joint Seals				
Physical Properties	Test Methods	EPDM	Neoprene	Butyl Mastic
Tear Resistance, ppi	ASTM D624 (Die B)	280	160	--
Rebound, percent, 5 minutes	ASTM C972 (mod.)	--	--	11
Rebound, percent, 2 hours	ASTM C972	--	--	12

2.2.8 Frames, Covers, and Gratings for Manholes

Frame and cover are to be cast gray iron, ASTM A48/A48M, Class 35B, cast ductile iron, ASTM A536, Grade 65-45-12, or reinforced concrete, ASTM C478 ASTM C478M. Frames and covers are to be circular without vent holes. Size are to be for 24 inch opening. Stamp or cast the words "Sanitary Sewer" into covers so that it is plainly visible.

2.2.9 Manhole Steps

Zinc-coated steel conforming to 29 CFR 1910.27 Aluminum steps or rungs will not be permitted. Steps are not required in manholes less than 4 feet deep.

2.2.10 Manhole Ladders

Provide a steel ladder where the depth of a manhole exceeds 12 feet. The ladder is not to be less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers are to be a minimum 3/8 inch thick and 2 inches wide. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Installation Drawings

Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.

3.2 INSTALLATION

Backfill after inspection by the Contracting Officer. Before, during, and after installation, protect plastic pipe and fittings from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer.

3.2.1 Connections to Existing Lines

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

3.2.2 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.2.2.1 Location

Terminate the work covered by this section at a point approximately 5 feet from the building.

3.2.2.1.1 Sanitary Sewer Manholes

No water piping must pass through or come in contact with any part of a sanitary sewer manhole.

3.2.2.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK 31 00 00 EARTHWORK31 00 00.

3.2.2.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell or groove ends in the upgrade direction. Adjust spigots in bells and tongues in grooves to give a uniform space all around. Blocking or wedging between bells and spigots or tongues and grooves will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Construct branch connections by use of regular fittings or solvent cemented saddles as approved. Provide saddles for PVC pipe conforming to Table 4 of ASTM D3034.

3.2.3 Special Requirements

3.2.3.1 Installation of PVC Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.2.4 Concrete Work

Cast-in-place concrete is included in Section 03 30 00 CAST-IN-PLACE

CONCRETE. Support the pipe on a concrete cradle, or encased in concrete where indicated or directed.

3.2.5 Manhole Construction

Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Perform cast-in-place concrete work in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.

3.2.6 Miscellaneous Construction and Installation

3.2.6.1 Connecting to Existing Manholes

Connect pipe to existing manholes such that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. Center the connection on the manhole. Holes for the new pipe are be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cut the manhole in a manner that will cause the least damage to the walls.

3.2.6.2 Metal Work

3.2.6.2.1 Workmanship and Finish

Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

3.2.6.2.2 Field Painting

After installation, clean cast-iron frames, covers, gratings, and steps not buried in concrete to bare metal, remove mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do

not paint surfaces subject to abrasion.

3.3 FIELD QUALITY CONTROL

The Contracting Officer will conduct field inspections and witness field tests specified in this section. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

3.3.1 Tests

Perform field tests and provide labor, equipment, and incidentals required for testing.

3.3.1.1 Hydrostatic Sewer Test

When unusual conflicts are encountered between sanitary sewer and waterlines a hydrostatic pressure sewer test will be performed in accordance with the applicable AWWA standard for the piping material or AWWA C600.

3.3.1.2 Leakage Tests for Nonpressure Lines

Test lines for leakage by either infiltration tests and exfiltration tests, negative air pressure tests or by low-pressure air tests. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

3.3.1.2.1 Negative Air Pressure Test3.3.1.2.1.1 Precast Concrete Manholes

Test precast concrete sewer manhole test in accordance with ASTM C1244. The allowable vacuum drop is located in ASTM C1244 Make calculations in accordance with the Appendix to ASTM C1244.

3.3.1.2.2 Low-Pressure Air Tests

3.3.1.2.2.1 PVC Pipelines

Test PVC pipe in accordance with UBPPA UNI-B-6. The allowable pressure drop is located in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

3.3.1.3 Deflection Testing

Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D2412. Deflection of pipe in the installed pipeline under external loads is not to exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

3.3.1.3.1 Pull-Through Device

This device is to be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Space circular sections on the shaft so that the distance from external faces of front and back sections will equal or exceed the diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections are to conform to the following:

a. A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.

b. Homogeneous material throughout, is to have a density greater than 1.0 as related to water at 39.2 degrees F, and a surface Brinell hardness of not less than 150.

c. Center bored and through-bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of not less than 70,000 psi, with eyes or loops at each end for attaching pulling cables.

d. Suitably Back each eye or loop with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

3.3.1.3.2 Deflection Measuring Device

Sensitive to 1.0 percent of the diameter of the pipe being tested and be accurate to 1.0 percent of the indicated dimension. Prior approval is required for the deflection measuring device.

3.3.1.3.3 Pull-Through Device Procedure

Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.

3.3.1.3.4 Deflection measuring device procedure

Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.

3.3.1.4 Smoke Test

Perform a smoke test on the relevant portion of the sewer system. Test results are to be noted in the daily Construction Quality Control (CQC) as required in 01 45 00 Quality Control.

a. Continue testing until it can be visually confirmed that the projects sanitary sewer point of connection has not been cross-connected to the storm drainage system.

b. During the test, monitor the storm drainage system, either manholes or outfalls, for any sign of cross-connection.

3.3.2 Inspection

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; the light must show a practically full circle of light through the pipeline when viewed from the adjoining end of line.

3.3.2.1 Pre-Installation Inspection

Prior to connecting the new service, perform pre-installation inspection after trenching and layout is complete. Submit Pre-Installation Inspection Request for field support at least 14 days in advance. The Installation's Utilities Field Support personnel will perform the pre-installation inspection.

3.3.2.2 Post-Installation Inspection

Perform a post-installation inspection after connection has been made and before the connection is buried. Submit Post-Installation Inspection Request for field support at least 14 days in advance. The Installation's Utilities Field Support personnel will perform the post-connection inspection. During the post-installation inspection the Contractor will be responsible for performing a smoke test.

-- End of Section --

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SECTION 33 40 00

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11/21

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SECTION 33 40 00

STORMWATER UTILITIES
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges
AASHTO M 190	(2004; R 2019) Standard Specification for Asphalt-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 243	(1996; R 2021) Standard Specification for Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2022) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A716	(2018; R 2022) Standard Specification for Ductile Iron Culvert Pipe
ASTM A760/A760M	(2015, R 2020) Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A798/A798M	(2022) Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM A807/A807M	(2019) Standard Practice for Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
ASTM A929/A929M	(2018) Standard Specification for Steel

	Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM B26/B26M	(2018; E 2018) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B745/B745M	(2015; R 2021) Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C32	(2013; R 2017) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C55	(2022) Standard Specification for Concrete Building Brick
ASTM C62	(2017) Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C139	(2022) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C231/C231M	(2022) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C270	(2019a; E 2019) Standard Specification for Mortar for Unit Masonry
ASTM C478/C478M	(2022) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C923/C923M	(2020) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM D1056	(2020) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1171	(2018) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking Outdoors (Triangular Specimens)
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2487	(2017; E 2020) Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F477	(2014; R 2021) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F679	(2016) Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F794	(2021) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Frame and Cover or Gratings; G, RO

SD-08 Manufacturer's Instructions

Placing Pipe; G, RO

SD-11 Closeout Submittals

Post-Installation Inspection Report; G, RO

LID Verification Report; G, RO

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Inspect materials delivered to site for damage and unload and store materials with minimumal handling. Do not store materials directly on the ground. Keep the inside of pipes and fittings free of dirt and debris. Before, during, and after installation, protect plastic pipe and fittings from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe in accordance with the manufacturer's recommendations and discard if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

1.3.2 Handling

Handle materials in a manner that ensures delivery to the trench in sound, undamaged condition. Carry pipe to the trench.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe sizes for culverts and storm drains are indicated on the drawings.

2.1.1 Ductile Iron Culvert Pipe

Provide ductile iron culvert pipe conforming to ASTM A716.

2.1.2 Poly Vinyl Chloride (PVC) Pipe

2.1.2.1 Type PSM PVC Pipe

ASTM D3034, maximum SDR 35.

2.1.2.2 Profile PVC Pipe

ASTM F794, Series 46.

2.1.2.3 Smooth Wall PVC Pipe

ASTM F679.

2.2 PIPE JOINTS

2.2.1 Corrugated Steel and Aluminum Pipe

Factory reform each end of pipe with helical corrugations to create annular corrugations of the same dimensions as those in the pipe. Provide reformed ends with a width equal to at least half the width of the band being used. Join pipe using annular corrugated or partially corrugated

coupling bands. Except as otherwise specified or indicated, provide annular corrugated or partially corrugated coupling bands including connectors and hardware conforming to ASTM A760/A760M or ASTM B745/B745M. Provide coupling bands with either rod and lug or angle-bolt type connectors.

2.2.1.1 Annular Corrugated Bands

Provide sleeve type gaskets made of approximately 3/8 inch thick by 7 inch minimum width closed cell, expanded synthetic rubber, fabricated in the form of a cylinder with a diameter approximately 10 percent less than the nominal pipe size with annular corrugated type bands. Provide sleeve type gaskets that meet the requirements of ASTM D1056, Type 2 and have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D1171

2.2.1.2 Partially Corrugated Bands

Provide partially corrugated type bands with two O-ring gaskets and a sealant strip where the band ends overlap. Provide rubber O-ring gaskets that are 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugation.

2.2.2 Ductile Iron Pipe

Provide push-on type joints with rubber gaskets.

2.2.3 PVC Plastic Pipe

Provide solvent cement or elastomeric gasket type joints in accordance with the specification for the pipe and as recommended by the pipe manufacturer. Use solvent cement conforming to ASTM D2564. Provide gaskets for elastomeric joints conforming to ASTM F477.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Concrete

Unless otherwise specified, provide concrete and reinforced concrete conforming to the requirements for 4000 psi concrete under Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide air content by volume of concrete mixture, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Determine air content in accordance with ASTM C231/C231M. Provide a minimum concrete covering over steel reinforcing of not less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. For concrete deposited directly against the ground, provide a covering thickness of at least 3 inches between steel and ground. Provide expansion-joint filler material conforming to ASTM D1751, or ASTM D1752, or provide be resin-impregnated fiberboard conforming to the physical requirements of ASTM D1752.

2.3.2 Mortar

Mortar is not allowed for pipe joints. Provide mortar for pipe connections to drainage structures conforming to ASTM C270, Type M, except that the maximum placement time will be 1 hour. Provide a sufficient quantity of water in the mixture to produce a stiff workable

mortar but in no case may the quantity exceed 5 gallons of water per sack of cement. Use water that is clean and free of harmful acids, alkalis, and organic impurities. Use the mortar within 30 minutes after the ingredients are mixed with water.

2.3.3 Precast Concrete Segmental Blocks

Provide precast concrete segmental block conforming to ASTM C139, not more than 8 inches thick, not less than 8 inches long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

2.3.4 Brick

Provide brick conforming to ASTM C62, Grade SW; ASTM C55, Grade S-I or S-II; or ASTM C32, Grade MS. Provide mortar for jointing and plastering consisting of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement. Provide joints that arecompletely filled and that are smooth and free from surplus mortar on the inside of the structure. Plaster brick structures with 1/2 inch of mortar over the entire outside surface of the walls. Lay brick in stretcher courses with a header course every sixth course for square or rectangular structures. Lay brick radially with every sixth course a stretcher course for round structures.

2.3.5 Precast Reinforced Concrete Manholes

Provide precast reinforced concrete manholes conforming to ASTM C478/C478M . Provide joints between precast concrete risers and tops that are full-bedded in cement mortar and smoothed to a uniform surface on both interior and exterior of the structure or made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph PIPE JOINTS.

2.3.6 Frame and Cover or Gratings

Provide frame and cover or gratings made of cast gray iron, ASTM A48/A48M, Class 35B; cast ductile iron, ASTM A536, Grade 65-45-12; or cast aluminum, ASTM B26/B26M, Alloy 356.0-T6. Stamp or cast the word "Storm Sewer" into covers so that it is plainly visible.

2.3.7 Steel Ladder

Provide a steel ladder where the depth of the storm drainage structure exceeds 12 feet. Provide ladders not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. Provide two stringers that are a minimum 3/8 inch thick and 2-1/2 inches wide. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M.

2.3.8 Resilient Connectors

Provide flexible, watertight connectors conforming to ASTM C923/C923M for connecting pipe to manholes and inlets.

2.3.9 Flared End Sections

2.3.9.1 Metal Flared End Sections

Provide sections of a standard design fabricated from zinc or aluminum (Type 2) coated steel sheets meeting requirements of ASTM A929/A929M.

2.3.9.2 Concrete Flared End Sections

Provide sections of a standard design fabricated with reinforced concrete.

2.3.10 Modular Trench Drains

Provide modular trench drains consisting of precast concrete sections. Provide trench with width and invert slope as indicated on the drawings. .

2.3.10.1 Precast Concrete Sections

Provide concrete sections made of fiber reinforced concrete or polyester polymer concrete with male/female connections between channel sections. Provide channels with ductile iron or galvanized steel or stainless steel edge rails.

2.3.10.2 Grates

Utilize ductile iron or cast iron or galvanized steel or stainless steel trench grates. Attach trench grates to sections as recommended by the manufacturer.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, BOX CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavate trenches, excavate for appurtenances and backfill for culverts and storm drains, in accordance with the applicable portions of Section 31 00 00 EARTHWORK and the requirements specified below.

3.1.1 Trenching

Excavate trenches to the width indicated on the drawings or as specified herein. Trench width should permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Place sheeting and bracing, where required, within the trench width as specified, without any overexcavation.

3.1.2 Removal of Rock

Replace rock in either ledge or boulder formation with suitable materials to provide a compacted earth cushion. Provide a compacted earth cushion between unremoved rock and the pipe with a thickness of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Maintain the cushion under the bell as well as under the straight portion of the pipe where bell-and-spigot pipe is used. Provide a compacted earth cushion between unremoved rock and the box culvert of at least 8 inches in thickness for concrete box culverts. Excavate rock as specified and defined in Section 31 00 00 EARTHWORK.

3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe or box culvert, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, remove such material to the depth required and replace with select granular material to the proper grade. Compact select granular material as specified in paragraph

FINAL BACKFILL. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, perform such removal and replacement at no additional cost to the Government.

3.2 BEDDING AND INITIAL BACKFILL

Provide a firm bedding foundation of uniform density throughout the entire length of the pipe or box culvert.

3.2.1 Concrete Pipe

Use select granular material conforming to Section 31 00 00 EARTHWORK for haunch and bedding material. Compact haunch and outer bedding to at least 90 percent laboratory maximum density and place in layers not exceeding 6 inch loose thickness for compaction by hand-operated compactors and 200 mm 8 inches for other than hand-operated machines. Loosely place middle bedding and do not compact. After the pipe has been properly bedded, place haunch material, at a moisture content that will facilitate compaction, evenly along both sides of the pipe and thoroughly compact each layer with mechanical tampers or rammers to the springline of the pipe. Thoroughly compact the haunch material under the haunches of the pipe. For bell and spigot pipe, form a depression in bedding material for bells so entire barrel of pipe is uniformly supported. Minimize the length, depth, and width of bell depressions to that required for properly making the particular type of joint.

3.2.1.1 Trenches

After the pipe has been properly bedded and haunch material placed to the midpoint (springline) of the pipe, backfill and compact the remainder of the trench by spreading and rolling or compacting by mechanical rammers or tampers in layers not exceeding 6 inches. Test for density as necessary to ensure conformance to the compaction requirements specified below. Leave untreated sheeting in place beneath structures or pavements.

3.2.1.2 Fill Sections

For pipe placed in fill sections, uniformly spread fill material longitudinally on both sides of the pipe in layers not exceeding 6 inches in compacted depth, and compact by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe must extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, place and thoroughly compact the remainder of the fill in layers not exceeding 8 inches.

3.2.2 Corrugated Steel and Aluminum Pipe

Provide bedding and structural backfill for corrugated steel and aluminum pipe and pipe arch in accordance with ASTM A798/A798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Structural backfill material consists of materials classified by ASTM D2487 as either GW, GM, GP-GM, GW-GM, GC, GP-GC or SW. Provide bedding for corrugated structural plate pipe meeting the requirements of ASTM A807/A807M.

3.2.3 Ductile Iron Pipe

Provide bedding for ductile iron pipe as shown on the drawings.

3.2.4 Plastic Pipe

Provide bedding for PVC, PE, SRPE and PP pipe meeting the requirements of ASTM D2321. Use Class IB or II material for PVC, PE, SRPE pipe bedding, haunching, and initial backfill. Use Class I, II, or III material for PP pipe bedding, haunching and initial backfill.

3.3 PLACING PIPE

Submit printed copies of the pipe or box culvert manufacturer's recommended pipe or box culvert installation procedures prior to installation. Thoroughly examine each section of pipe or box culvert before being laid; do not use defective or damaged pipe. Protect plastic pipe, excluding SRPE pipe, from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Lay pipelines to the grades and alignment indicated. Provide proper facilities for lowering sections of pipe into trenches. Do not lay pipe in water or when trench conditions or weather are unsuitable for such work. Divert drainage or dewater trenches during construction as necessary. Deflection of installed flexible pipe must not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (percent)

Type of Pipe	Max Allowable Deflection
Ductile Iron Pipe	3%
Plastice	5%

3.3.1 Concrete, Clay, PVC, Ribbed PVC, Ductile Iron Pipe

Lay pipe proceeding upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

3.3.2 Corrugated Steel and Aluminum Pipe and Pipe Arch

Lay pipe with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Install part paved pipe so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Provide fully paved steel pipe or pipe arch with the sheet thickness of the pipe or pipe arch painted or otherwise

indicated on a label applied on the inside of the pipe or pipe arch. Coat any unprotected metal in the joints with bituminous material as specified in AASHTO M 190 or AASHTO M 243. Protect interior coating against damage from insertion or removal of struts or tie wires. Use lifting lugs to facilitate moving pipe without damage to exterior or interior coatings. Handle pipe or pipe arch and coupling bands during transportation and installation with care to preclude damage to the coating, paving or lining. Repair damaged coatings, pavings and linings in accordance with the manufacturer's recommendations prior to placing backfill. Remove and replace pipe on with coating, paving or lining that has been damaged to such an extent that satisfactory field repairs cannot be made. Accomplish vertical elongation, where indicated, in the factory. Provide suitable markings or properly placed lifting lugs to ensure placement of factory elongated pipe in a vertical plane.

3.3.3 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe must be at least half the nominal pipe diameter or 3 feet apart, whichever is less.

3.4 JOINTING

3.4.1 Concrete and Clay Pipe

3.4.1.1 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe and Box Culverts

Follow the recommendation of the particular manufacturer in regard to sealing compound special installation requirements. When lubricants, primers, or adhesives are used, only apply on surfaces that are dry and clean. Affix sealing compounds to the pipe or box culvert not more than 3 hours prior to installation of the pipe or box culvert. Protect sealing compounds from the sun, blowing dust, and other deleterious agents at all times. Inspect sealing compounds before installation of the pipe or box culvert, and remove and replace any loose or improperly affixed sealing compound. Align the pipe or box culvert with the previously installed pipe or box culvert, and pull the joint together.

3.4.1.2 Flexible Watertight Joints

Use lubricants, cements, adhesives, and other special installation requirements for gaskets and jointing materials as recommended by the manufacturer. When lubricants, cements, or adhesives are used, only apply on surfaces that are clean and dry. Affix gaskets and jointing materials to the pipe not more than 24 hours prior to the installation of the pipe, and protect from the sun, blowing dust, and other deleterious agents at all times. Inspect gaskets and jointing materials before installing the pipe; remove and replace any loose or improperly affixed gaskets and jointing materials. Align the pipe with the previously installed pipe, and push the joint home. If the gasket becomes visibly dislocated when joining sections of pipe, remove the pipe and remake the joint.

3.4.2 Corrugated Steel and Aluminum Pipe

3.4.2.1 Field Joints

Provide transverse field joints designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. Provide joints meeting the general

performance requirements described in ASTM A798/A798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. Keep the space between the pipe and connecting bands free from dirt and grit so that corrugations fit snugly. While being tightened, tap the connecting band with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. Provide field joints for each type of corrugated metal pipe that maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations.

3.4.2.2 Flexible Watertight, Gasketed Joints

Use lubricants or cements and other special installation requirements as recommended by the gasket manufacturer. Where sleeve type gaskets are used, place the gasket over one end of a section of pipe for half the width of the gasket. Then double over the other half over the end of the same pipe. When the adjoining section of pipe is in place, roll the doubled-over half of the gasket over the adjoining section. Correct any unevenness in overlap so that the gasket covers the end of pipe sections equally. Center connecting bands over adjoining sections of pipe, and place rods or bolts in position and tighten nuts. Band Tightening: Tighten the band evenly, keep even tension on the rods or bolts, and the gasket; properly seat the gasket in the corrugations. Keep watertight joints uncovered for a period of time designated by the Contracting Officer. Before covering joints, measure the tightness of the nuts with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, retighten the nut with a torque wrench and keep uncovered until a tight, permanent joint is assured.

3.5 DRAINAGE STRUCTURES

3.5.1 Manholes and Inlets

Construct manholes of precast reinforced concrete. Construct inlets of precast or cast in place reinforced concrete. Provide manholes and inlets complete with frames and covers or gratings; and with fixed galvanized steel ladders as indicated. The wall along the line where steel ladders are installed must be vertical for its entire length. Adequately anchor ladders to the wall by means of steel inserts spaced not more than 6 feet vertically, and install to provide at least 6 inches of space between the wall and the rungs. Make pipe connections to concrete manholes and inlets with flexible, watertight connectors.

3.5.2 Walls and Headwalls

Construct walls headwalls as indicated.

3.6 INSTALLATION OF TRACER WIRE AND WARNING TAPE

Install a continous length of tracer wire for the full length of each run of nonmetallic pipe in accordance with Section 31 00 00 EARTHWORK. Attach wire to top of pipe in such a manner that it will not be displaced during construction operations. Install warning tape above all storm drain pipe in accordance with Section 31 00 00 EARTHWORK.

3.7 FINAL BACKFILL

Backfill trenches with satisfactory material deposited in layers of a maximum of 8 inches loose thickness and compacted to 90 percent of maximum density for cohesive soils and 95 percent of maximum density for cohesionless soils in accordance with Section 31 00 00 EARTHWORK. Testing is the responsibility of the Contractor and will be performed at no additional cost to the Government. Unless otherwise specified, determine field in-place density of final backfill at a frequency of one test per 50 linear feet, or fraction thereof, of each lift of backfill. Submit test results in accordance with Section 31 00 00 EARTHWORK. Do not displace or damage pipe or box when compacting final backfill by rolling or operating heavy equipment parallel with the pipe or box. Movement of construction machinery over a culvert or storm drain at any stage of construction will be at the Contractor's risk. Repair or replace any damaged pipe. Protect concrete pipes with a minimum of 3 feet of cover prior to permitting heavy construction equipment to pass over them during construction. Provide the minimum cover for construction loads over corrugated steel pipes as specified in Section 26, Division II of AASHTO HB-17. Provide minimum cover for construction loads over plastic pipes as specified in ASTM D2321.

3.8 FIELD QUALITY CONTROL

3.8.1 Inspection

3.8.1.1 Post-Installation Inspection

Inspect each segment of pipe for alignment, settlement, joint separations, soil migration through the joint, cracks, buckling, bulging and deflection. An engineer must evaluate all defects to determine if any remediation or repair is required.

3.8.1.1.1 Concrete Pipe

An engineer must evaluate all pipes with cracks with a width greater than 0.25 mm 0.01 inches, but less than 0.10 inches to determine if any remediation or repair is required.

3.8.1.1.2 Flexible Pipe

Check each flexible pipe (PE, PVC, PP, corrugated steel and aluminum) for rips, tears, joint separations, soil migration throught the joint, cracks, localized buckling, bulges, settlement and alignment.

3.8.1.1.3 Post-Installation Inspection Report

The deflection results and final post installation inspection report must include: pipe location identification, equipment used for inspection, inspector name, deviation from design, grade, deviation from line, deflection and deformation of flexible pipe, inspector notes, condition of joints, condition of pipe wall (e.g. distress, cracking, wall damage dents, bulges, creases, tears, holes, etc.).

3.8.1.2 Low Impact Development Inspection

Inspect Low Impact Development (LID) features indicated on the design portion of the LID Verification Report. Certify LID features were constructed according to plans and specifications or by submitting

as-built drawings in accordance with Section 01 78 39.00 24 AS-BUILT DRAWINGS. When as-built drawings show deviations to the LID features, document the deviations on the LID Verification Report.

3.8.2 Repair of Defects

3.8.2.1 Leakage Test

When leakage exceeds the maximum amount specified, correct source of excess leakage by replacing damaged pipe and gaskets and retest.

3.8.2.2 Deflection Testing

When deflection readings are in excess of the allowable deflection of average inside diamater of pipe are obtained, remove pipe which has excessive deflection and replace with new pipe. Retest 30 days after completing backfill, leakage testing and compaction testing.

3.8.2.3 Inspection

Replace pipe or repair defects indicated in the Post-Installation Inspection Report.

3.8.2.3.1 Concrete Pipe

Replace pipes having cracks with a width greater than 0.1 inches.

3.8.2.3.2 Flexible Pipe

Replace pipes having cracks or splits.

3.9 PROTECTION

Protect storm drainage piping and adjacent areas from superimposed and external loads during construction.

3.10 WARRANTY PERIOD

Pipe segments found to have defects during the warranty period must be replaced with new pipe and retested.

-- End of Section --

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SECTION 33 52 10

DIESEL EXHAUST FLUID SYSTEMS PIPING (SERVICE STATION)
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PART 1 GENERAL

1.1 SUMMARY

This section defines the requirements for pipe, piping components, and valves as related to small diesel exhaust fluid distribution systems (non-aviation type). Provide the entire diesel exhaust fluid distribution system as a complete and fully operational system. Size, select, construct, and install system components to operate together as a complete system. Substitutions of functions specified herein will not be acceptable. Coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system. Design system components and piping specified herein to handle a working pressure of 275 psig at 100 deg F. System components specified herein must be compatible with the diesel exhaust fluid to be handled. Components must be suitable for inside, sheltered location, and to function normally in ambient temperatures between 40 degrees F and 100 degrees F.

1.1.1 Related Sections

1.1.1.1 Welding

Welding activities for pipe and piping components must be in accordance with Section 33 52 23.15 POL SERVICE PIPING WELDING.

1.1.1.2 Earthwork

Excavate and backfill piping as specified in Section 31 00 00 EARTHWORK.

1.1.1.3 Cathodic Protection

Provide buried metallic components including pipe, anchors, and conduit with a cathodic protection system as specified in Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE CATHODIC PROTECTION (GACP) SYSTEM. Cathodic protection for metal components that attach to a tank must be coordinated and compatible with the tank corrosion control system.

1.1.1.4 Concrete Manholes

Construct manhole of concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 540 (1999; R 2004) Electrical Installations in

	Petroleum Processing Plants
API RP 1110	(2013; R 2018) Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API STD 600	(2015) Steel Gate Valves-Flanged and Butt-welding Ends, Bolted Bonnets
API STD 608	(2012) Metal Ball Valves - Flanged, Threaded, And Welding End
API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves
API Spec 17J	(2016; Errata 2 2017; ADD 1 2017) Specification for Unbonded Flexible Pipe
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B31.3	(2022; Errata 2023) Process Piping
ASME B40.200	(2008; R 2013) Thermometers, Direct Reading and Remote Reading
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN WELDING SOCIETY (AWS)

AWS BRH	(2007; 5th Ed) Brazing Handbook

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe,

	Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A182/A182M	(2023) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A269/A269M	(2022) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A358/A358M	(2019) Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A733	(2016; R 2022) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B687	(1999; R 2023) Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F844	(2019) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024) Flammable and Combustible Liquids Code
NFPA 30A	(2024; ERTA 1 2023) Code for Motor Fuel Dispensing Facilities and Repair Garages
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 77	(2024) Recommended Practice on Static Electricity
NFPA 110	(2022) Standard for Emergency and Standby Power Systems
NFPA 407	(2022; TIA 21-1) Standard for Aircraft Fuel Servicing
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE J514	(2012) Hydraulic Tube Fittings

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-13789	(1999; Rev E; Notice 1 2008; Notice 2 1016; Notice 3 2021) Strainers, Sediment: Pipeline, Basket Type

UL SOLUTIONS (UL)

UL 971	(1995; Reprint Mar 2006) UL Standard for Safety Nonmetallic Underground Piping for

Flammable Liquids

1.3 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding

Pipe Supports

SD-03 Product Data

Stainless Steel Pipe; G, RO

Flexible Non-Metallic Pipe; G, RO

Steel Reinforced Flexible Pipe; G, RO

Joint Compound; G, RO

Strainer; G, DO

Thermometers; G, DO

Pressure Gauge; G, DO

Ball Valves; G, DO

Swing Type Check Valves; G, RO

Tank Overfill Prevention Valve (Pumped Fuel Receipt); G, DO

Diaphragm Pump; G, DO

Pump Control Panel; G, DO

SD-06 Test Reports

Preliminary Pneumatic Test

Final Pneumatic Test

Hydrostatic Test

Exterior Containment Piping Tests

SD-07 Certificates

Contractor Qualifications; G, RO

Licensed Personnel

Pipeline Inventory; G, RO

Demonstrations

SD-08 Manufacturer's Instructions

SD-10 Operation and Maintenance Data

Strainer; G, RO

Thermometers; G, RO

Ball Valves; G, RO

Swing Type Check Valves; G, RO

Tank Overfill Prevention Valve (Pumped Fuel Receipt); G, RO

Diaphragm Pump; G, RO

Pump Control Panel; G, RO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 QUALITY ASSURANCE

1.4.1 Contractor Qualifications

Each installation Contractor must have successfully completed at least 3 projects of the same scope and the same size, or larger, within the last 6-years; demonstrate specific installation experience in regard to the specific system installation to be performed; have taken, if applicable, manufacturer's training courses on the installation of piping; and meet the licensing requirements in the state. Experience must include the erection of piping systems in compliance with the requirements of ASME B31.3, NFPA 30, NFPA 30A, NFPA 110NFPA 110, and NPFPA 400. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed providing in the letter evidence of prior manufacturer's training and state licensing.

1.4.2 Regulatory Requirements

1.4.2.1 Licensed Personnel

Pipe installers must be licensed/certified when the state, city or locality requires licensed installers.

1.4.3 Design Data

1.4.3.1 Pipeline Inventory

Diesel exhaust fluid system volume must be calculated using as constructed pipe lengths, internal diameters, fittings, and components. Totals must be provided for all items containing diesel exhaust fluid with the exception of tanks which is covered by other specifications. A certified pipeline inventory with sizes, lengths, quantity, and volumes must be provided for the systems in this project.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.6 PROJECT/SITE CONDITIONS

Diesel exhaust fluid required for the testing, flushing and cleaning efforts, as specified in this section, will be provided and delivered by the Contracting Officer. Diesel exhaust fluid used in the system will remain the property of the Government. Diesel exhaust fluid shortages not attributable to normal handling losses must be reimbursed to the Government.

PART 2 PRODUCTS

2.1 ELECTRICAL WORK

2.1.1 General

Motors, manual or automatic motor control system components except where installed in motor control centers, and protective or signal devices required for the operation specified herein must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.1.2 Grounding and Bonding

Ground and bond in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.2 MATERIALS AND SYSTEM COMPONENTS

Internal parts and components of system components, piping, piping components, and valves that could be exposed to diesel exhaust fluid during system operation must not be constructed of stainless-steel metal or high-density polyethylene. Do not install cast iron bodied valves in piping systems that could be exposed to diesel exhaust fluid during system operation.

2.2.1 Standard Products

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products; that are of a similar material, design and workmanship; and that have been in satisfactory commercial or industrial use for a minimum 2-years prior to bid opening. The 2-year period must include applications of the system components and materials under similar circumstances and of similar size. Materials and system components must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

2.2.2 Nameplates

Attach nameplates to all specified system components, thermometers, gauges, and valves defined herein. List on each nameplate the manufacturer's name, address, contract number,acceptance date, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of stainless steel. Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be 1 by 2.5 inches. Lettering must be the normal block style with a minimum 0.25 inch height. Accurately align all lettering on nameplates. Key the nameplates to a chart and schedule for each system. Frame charts and schedule under glass, and locate where directed near each system. Furnish two copies of each chart and schedule. Each nameplate description must identify its function.

2.3 Threaded END CONNECTIONS

2.3.1 Threads

Provide threaded end connections on system components, fittings, piping, piping components, adapters, couplers,and valves that conform to ASME B16.11, Class 2000.

2.3.1.1 Stainless Steel

Stainless steel threads must conform to ASTM A182/A182M, Grade F304, forged type.

2.4 PIPE

Pipe must meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein.

2.4.1 Stainless Steel Pipe

Provide stainless steel pipe that complies with one of the following:

a. Pipe must conform to ASTM A312/A312M, Type TP304L, seamless only. Pipe smaller than 8 inches must be Schedule 40S. Pipe 8 inches or larger must be Schedule 10S.

b. Pipe must conform to ASTM A358/A358M, Grade 304L, Class 1 or 3, longitudinally welded. Radiographically inspect 100 percent of factory longitudinal welds in accordance with ASME BPVC SEC VIII D1. Minimum pipe wall thickness must be 0.25 inch for pipe 12 inches and smaller; 0.312 inch for pipe larger than 12 inches.

2.4.1.1 Fittings 2-1/2-inch and Larger

Provide buttwelded type fittings that complies with one of the following:

a. Stainless steel conforming to ASTM A403/A403M, Class WP-S, Grade WP 304L, seamless only and ASME B16.9 of the same thickness as the adjoining pipe.

b. Stainless steel conforming to ASTM A403/A403M, Class WP-XX, Grade WP 304L, of wall thickness as indicated. Do not fabricate starting material by the fusion welding process without addition of filler metal. Forming will not be allowed using fusion welding process without addition of filler metal. Radiographically inspect all factory longitudinal welds in accordance with ASME BPVC SEC VIII D1.

2.4.1.2 Fittings 2-inch and Smaller

Socket welded type fittings, unless indicated otherwise, must conform to ASME B16.11. Fitting materials must be stainless steel that conforms to ASTM A182/A182M, Type F304L.

2.4.1.3 Control Tubing

Piping must be seamless, fully annealed stainless steel tubing conforming to ASTM A269/A269M, Grade TP316, with a hardness number not exceeding 80 HRB. For 1/2-inch tubing, provide a minimum 0.049 inch tubing wall thickness.

2.4.1.4 Control Tubing Fittings

Fittings must be the flareless, Type 316 stainless steel type conforming to SAE J514.

2.4.2 Flexible Non-Metallic Pipe

Piping must conform to UL 971. Piping must be installed in manufacturers supplied corrugated, flexible, access piping. Size is limited to 3-inch diameter or less. For piping larger than 3 inches use the carbon steel piping system described in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

2.4.3 Steel Reinforced Flexible Pipe

Steel Reinforced High Density Polyethylene (HDPE) flexible piping must be manufactured in accordance with API Spec 17J and consist of an inner layer of HDPE material, a steel reinforcing layer and an outer HDPE protective layer.

2.4.3.1 Steel Reinforced Flexible Pipe Fittings

End connections and mid-line connections for steel reinforced high density polyethylene (HDPE) flexible pipe must be of stainless steel swaged onto the pipe ends.

End connections must terminate in flanged end or weld ends as indicated. Mid-line connections must terminate in flanged fittings if they are in a pit or double swage type if they are not.

2.5 PIPING COMPONENTS

Provide piping components that meet the material, fabrication and operating requirements of ASME B31.3, except as modified herein. Pressure design class for piping components must be Class 150 as defined in ASME B16.5.

2.5.1 Welded Nipples

Nipples must conform to ASTM A733 or ASTM B687 and be constructed of the same material as the connecting pipe.

2.5.2 Steel Couplings

Couplings must conform to API Spec 5L, seamless, extra heavy, wrought steel with recessed ends.

2.5.3 Threaded Unions

Unions must conform to ASME B16.11, Class 2000. Unions materials must conform to ASTM A312/A312M, Grade 304 or 316. Dielectric unions must conform to dimensional, strength, and pressure requirements of ASME B16.11, Class 2000.

2.5.4 Joint Compound

Joint compounds must be resistant to water, urea, and be suitable for use with Diesel Exhaust Fluid (DEF) without causing contamination or degradation of the fluid.

2.5.5 Strainer

Strainer must be single, basket type, arranged in a simplex configuration as indicated in compliance with MIL-PRF-13789, except as specified otherwise. Strainer end connections must be designed in accordance with ASME B16.5. Strainer body material must be the same as the material specified for manual valves. Strainers must have removable baskets of 100 mesh wire screen with larger wire mesh reinforcement; wire must be stainless steel, Type 316. Pressure drop for clean strainer must not exceed 3 psig at maximum design flow rate. The ratio of net effective strainer area to the area of the connecting pipe must be not less than three to one. Each strainer must be provided with a suitable drain at the bottom, equipped with a ball valve. The strainer must be equipped with a direct-reading, piston type differential pressure gauge that measures the differential pressure across the basket as per Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.5.6 Thermometers

Analog, dial-type bimetallic actuated type that conforms to ASME B40.200. Thermometer must have a 5 inch diameter dial, a hermetically sealed stainless steel case, a stainless steel stem, a safety glass face, a fixed threaded connection, and a scale range as indicated. Thermometer accuracy must be within one percent of the scale range.

2.5.7 Pressure Gauge

See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.5.8 Pipe Supports

Supports must be the adjustable type conforming to MSS SP-58, except as modified herein. Provide hot-dipped galvanized finish on rods, nuts, bolts, washers, hangers, and supports. Provide miscellaneous metal that conforms to ASTM A36/A36M, standard mill finished structural steel shapes, hot-dipped galvanized.

2.5.8.1 Pipe Protection Shields

Shields must conform to MSS SP-58, Type 40, except material must be Type 316 stainless steel. Provide shields at each slide type pipe hanger and support.

2.5.8.2 Low Friction Supports

Supports must have self-lubricating anti-friction bearing elements composed of 100 percent virgin tetrafluoroethylene polymer and reinforcing aggregates, prebonded to appropriate backing steel members. The coefficient of static friction between bearing elements must be 0.06 from initial installation for both vertical and horizontal loads and deformation must not exceed 0.002 inch under allowable static loads. Bonds between material and steel must be heat cured, high temperature epoxy. Design pipe hangers and support elements for the loads applied. Provide anti-friction material with a minimum of 0.09 inch thick. Provide hot-dipped galvanized steel supports. Provide supports that are factory designed and manufactured.

2.6 MANUAL VALVES

All portions of a valve coming in contact with Diesel Exhaust Fluid (DEF) must be of noncorrosive material. Valves in stainless steel pipe lines must be Type 304 or Type 316. Stem and trim must be stainless steel for all valves. Manually operated valves 6 inches and larger must be worm-gear operated and valves smaller than 6 inches must be lever operated or handwheel operated. Valves smaller than 2 inches must have lever-type handles. Handles installed more than 6 feet above finished floor must have chain operators. Valve indicators installed higher than 5 feet must have a position indicator visible from ground level.

2.6.1 Ball Valves

Ball valves must be fire tested and qualified in accordance with the requirements of API Std 607 and API STD 608. Seal material for the fire test must be graphite, seal material for the project must be as indicated below. Ball valves must be nonlubricated valves that operate from fully open to fully closed with 90 degree rotation of the ball. Valves 2 inches and larger must conform to applicable construction and dimension requirements of API Spec 6D, ANSI Class 150 and must have flanged ends. Valves smaller than 2 inches must be ANSI class 150 valves with flanged ends, unless noted otherwise. The balls in valves 10 inchesand larger full port and 12 inch and larger regular port and larger must have trunnion type support bearings. Except as otherwise specified or indicated, reduced port or full port valves may be provided at the Contractor's option. Balls must be solid, not hollow cavity.

2.6.1.1 Materials

Ball must be stainless steel. Ball valves must have

polytetrafluoroethylene (PTFM) or fluoroelastomer (FKM), commonly referred to as Viton seats, body seals and stem seals.

2.6.1.2 Electric Valve Actuator

Electric valve actuator must be as indicated for electric valve actuator.

2.6.2 Swing Type Check Valves

Swing check valves must conform to API STD 600, regular type, ANSI Class 150 with flanged end connections. Discs and seating rings must be renewable without removing the valve from the line. The disc must be guided and controlled to contact the entire seating surface.

2.6.3 Tank Overfill Prevention Valve (Pumped Fuel Receipt)

Valve must be the two-stage, float-activated, shutoff type that is an integral part of the drop tube used for pressurized fill systems. The valve must completely stop the flow of fuel into the tank, when the liquid level rises above 96.5 percent of tank capacity. Valve must be constructed of the same material as the fill tube.

2.7 PUMPS

2.7.1 Diaphragm Pump

Pumps used for Diesel Exhaust Fluid (DEF) must be driven by a motor suitable for use in environments where DEF is handled, ensuring compliance with relevant safety standards. Pump assemblies must be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow. Additionally, pump motors must be non-overloading throughout their entire pump curve.

2.7.2 Pump Control Panel

Panel must include on and off indication lights for each pump. Panel must contain an adjustable control logic for pump operation in accordance with the indicated operation. Panel must also have a manual override switch for each pump to allow for the activation or deactivation of each pump. See Section 33 09 52 FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT).

2.8 ACCESSORIES

2.8.1 Concrete Anchor Bolts

Concrete anchors must conform to ASTM A307, Grade C, hot-dipped galvanized.

2.8.2 Bolts and Studs

Carbon steel bolts and studs must conform to ASTM A307, Grade B, hot-dipped galvanized. Stainless steel bolts and studs must conform to ASTM A193/A193M, Class 2, Grade 8.

2.8.3 Nuts

Carbon steel nuts must conform to ASTM A563, Grade A, hex style, hot-dipped galvanized. Stainless steel nuts must conform to ASTM A194/A194M, Grade 8.

2.8.4 Washers

Provide flat circular washers under each bolt head and each nut. Washer materials must be the same as the connecting bolt and nut. Carbon steel washers must conform to ASTM F844, hot-dipped galvanized. Stainless steel washers must conform to ASTM A194/A194M, Grade 8.

2.8.5 Polytetrafluoroethylene (PTFE) Tape

Tape must conform to ASTM D3308.

2.8.6 Pipe Sleeves

Provided sleeves constructed of hot-dipped galvanized steel, ductile iron, or cast-iron pipe, conforming to ASTM A53/A53M, Standard weight.

2.9 FINISHES

Ship, store, and handle coating materials as well as apply and cure coatings in accordance with SSPC PA 1.

PART 3 EXECUTION

3.1 INSTALLATION

Installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.3 ,NFPA 30, NFPA110, and NPFPA 400, except as modified herein. Safety rules as specified in NFPA 30, NFPA 110, and NFPA 400 must be strictly observed. Never direct bury threaded connections, socket welded connections, unions, flanges, valves, air vents, or drains. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

3.1.1 Pumps

Properly level, align, and secure pumps in place in accordance with manufacturer's instructions. Support, anchor, and guide so that no strains are imposed on a pump by weight or thermal movement of piping. Provide floor-mounted pumps with mechanical vibration isolators or a vibration isolation foundation.

3.1.2 Piping

3.1.2.1 General

Thoroughly clean pipe of all scale and foreign matter before the piping is assembled. Cut pipe accurately to measurements established at the jobsite, and worked into place without springing or forcing. Cut pipe square and have burrs removed by reaming. Install pipe to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval.

a. Use reducing fittings for changes in pipe sizes. Install system components and piping into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing,

and maintenance. Provide electric isolation fittings between dissimilar metals. Install piping straight and true to bear evenly on supports. Piping must be free of traps, must not be embedded in concrete pavement, and must drain as indicated. Make changes in direction with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted.

b. The centerline radius of bends must not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted. When work is not in progress, securely close open ends of pipe and fittings with an expandable pipe plug so that water, earth, or other substances cannot enter the pipe or fittings. For belowground piping, the full length of each pipe must rest solidly on the underlying pipe bed.

3.1.2.2 Double-Wall Flexible Non-Metallic Piping

Install double-wall flexible non-metallic piping in accordance with manufacturer's instructions.

3.1.2.3 Stainless-steel Reinforced Flexible Pipe

Connections between stainless-steel pipe and stainless-steel reinforced flexible pipe and between separate lengths of stainless-steel reinforced flexible pipe must not be made aboveground but must be made either inside a pit or vault, or direct bury them. Where practicable, end-line and mid-line connections must be located inside pit type enclosures of an appropriate size. Where it is not practicable to locate mid-line connections inside pit type enclosures, mid-line connections may be wrapped with a suitable waterproof protective substance and direct buried underground. The location of direct buried mid-line connections must be indicated on the final drawings and provided with a pipeline marker.

3.1.2.4 Threaded End Connections

Provide threaded end connections only on piping 2 inches in nominal size or smaller and only where indicated on the drawings. Provide threaded connections with PTFE tape or equivalent thread-joint compound applied to the male threads only. Not more than three threads must show after the joint is tighten.

3.1.2.5 Brazed Connections

Provide brazing in accordance with AWS BRH, except as modified herein. During brazing, fill pipe and fittings with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, clean both the outside of the tube and the inside of the fitting with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Remove surplus brazing material at all joints. Support piping prior to brazing and do not be spring or force piping.

3.1.3 Bolted Connections

For each bolted connection of stainless steel components (e.g., pipes, piping components, valves, and system components) use stainless steel bolts or studs, nuts, and washers. For each bolted connection of carbon

steel components, use carbon steel bolts or studs, nuts, and washers. Bolts to project no more than three full threads and no less than two full threads beyond the nuts with the bolts tightened to the required torque. Prior to installing nuts, apply a compatible anti-seize compound to the male threads.

3.1.4 Flanges and Unions

Except where threaded end connections or unions are indicated, provide flanged joints in each line immediately preceding the connection to a system component or material requiring maintenance such as pumps, general valves, control valves, strainers, and other similar items and as indicated. Assemble flanged joints square and tight with matched flanges, gaskets, and bolts. For flanges, provide washers under each bolt head and nut. Torque wrenches must be used to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tightening pattern must be as recommended by the gasket manufacturer. Use anti-seize compound on threads for stainless steel bolts.

3.1.5 Valves

Install isolation plug or ball valves on each side of each system component, at the midpoint of looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Install valves with stems vertically up unless otherwise indicated. Provide individual supports and anchors for each valve.

3.1.6 Pipe Sleeves

Provide a pipe sleeve around any pipe that penetrates a wall, floor, or crosses under a roadway. Do not install sleeves in structural members except where indicated or approved. Install pipe sleeves in masonry structures at the time of the masonry construction. Sleeves must be of such size as to provide a minimum of 1/2 inch all-around clearance between bare pipe and the sleeve. Align sleeve and piping such that the pipe is accurately centered within the sleeve by a nonconductive centering element. Securely anchor the sleeve to prevent dislocation. Closure of the space between the pipe and the pipe sleeve must be by means of a mechanically adjustable segmented elastomeric seal. The seal must be installed so as to be flush. For wall or floor penetrations, extend each sleeve through its respective wall or floor and cut flush with each surface. For roadway crossings, pipe sleeves must be continuous for the entire crossing as well as extend a minimum of 6 inches beyond both sides of the crossing. Seal around sleeves that penetrate through valve or fuel related pits with a Buna-N casing seal. Seal around sleeves that penetrate through non-fire-rated walls and floors in accordance with Section 07 92 00 JOINT SEALANTS. Seal around sleeves that penetrate through fire-rated walls and floors as specified in Section 07 84 00 FIRESTOPPING.

3.1.7 Framed Instructions

Framed instructions must include system components layout, wiring and control diagrams, piping, valves, control sequences, and typed condensed operation instructions. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. Frame under glass or laminated plastic the framed instructions and post where directed by the Contracting Officer. Post the

framed instructions before the system performance tests.

3.2 PIPE SUPPORTS

Install supports with a maximum spacing as defined in Table 1 below, except where indicated otherwise. In addition to meeting the requirements of Table 1, provide additional supports where concentrated piping loads exist (e.g., valves).

Table 1. Maximum Support Spacing

Nominal Pipe Size (Inches)	One and Under	1.5	2	3	4	6	8	10	12
Maximum Support Spacing (ft)	7	9	10	12	14	17	19	22	23

3.2.1 Seismic Requirements

Support and brace piping and attach valves to resist seismic loads as specified under Section 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT as shown on the drawings. Structural steel required for reinforcement to properly support piping, headers, and system components but not shown must be provided under this section. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.2.2 Structural Attachments

Provide attachments to building structure concrete and masonry by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Apply inserts and anchors with a safety factor not less than 5. Do not attach supports to metal decking. Construct masonry anchors for overhead applications of ferrous materials only. Structural steel brackets required to support piping, headers, and system components, but not shown, must be provided under this section. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.3 FIELD QUALITY CONTROLS

3.3.1 System Commissioning

System commissioning must conform to Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

3.3.2 Tests

Furnish labor, materials, equipment, electricity, repairs, and retesting necessary for any of the tests required herein. Perform piping test in accordance with the applicable requirements of ASME B31.3 except as modified herein. To facilitate the tests, various sections of the piping

system may be isolated and tested separately. Where piping sections terminate at flanged valve points, close the line by means of blind flanges in lieu of relying on the valve. Provide tapped flanges to allow a direct connection between the piping and the air compressor or pressurizing pump. Use tapped flanges for gauge connections. Taps in the permanent line will not be permitted. Gauges will be subject to testing and approval. Provide provisions to prevent displacement of the piping during testing. Keep personnel clear of the piping during pneumatic testing. Only authorized personnel must be permitted in the area during pneumatic and hydrostatic testing. Isolate system components such as pumps, tanks and meters from the piping system during the testing. Do not exceed the pressure rating of any component in the piping system during the testing. Following satisfactory completion of each test, relieve the test pressure and seal the pipe immediately. Piping to be installed underground must not receive field applied exterior coatings at the joints or be covered by backfill until the piping has passed the final pneumatic tests described herein.

3.3.2.1 Preliminary Pneumatic Test

Apply a 25 psig pneumatic test to product piping. Maintain the pressure while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). If leaks are discovered, repair the leaks accordingly and retest.

3.3.2.2 Final Pneumatic Test

Following the preliminary pneumatic test, apply a 50 psig pneumatic test to all product piping and hold for a period not less than 2-hours. During the test period, there must be no drop in pressure in the pipe greater than that allowed for thermal expansion and contraction. Disconnect the pressure source during the final test period. If leaks are discovered, repair the leaks accordingly and retest.

3.3.2.3 Hydrostatic Test

Testing must comply with the requirements in ASME B31.3, except as modified herein. Hydrostatically test product piping with the fuel to be handled to the lesser of 1-1/2 times operating pressure or 275 psig in accordance with API RP 1110. Maintain the pressure within the piping for 4-hours with no leakage or reduction in gauge pressure. If leaks are discovered, repair the leaks accordingly and retest.

3.3.2.4 Exterior Containment Piping Tests

Apply a minimum pneumatic pressure of 5 psig to the exterior containment piping. Maintain the pressure for at least 1-hour while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). Repair leaks discovered in accordance with manufacturer's instructions and retest. Perform testing in compliance with the manufacturer's published installation instructions.

3.4 SYSTEM PERFORMANCE TESTS

Conform tests to Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

3.5 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the system components and specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/system components/systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of 3 hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training.

-- End of Section --

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POL SERVICE PIPING WELDING
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	(2020) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC V	(2017) BPVC Section V-Nondestructive Examination

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0M/A3.0	(2020) Standard Welding Terms and Definitions
AWS A5.1/A5.1M	(2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS A5.3/A5.3M	(1999; R 2007) Specification for Aluminum and Aluminum-Alloy Electrodes for Shielded Metal Arc Welding
AWS A5.4/A5.4M	(2012; R 2022) Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding
AWS A5.9/A5.9M	(2022) Welding Consumables-Wire Electrodes, Strip Electrodes, Wires, and Rods for Arc Welding of Stainless and Heat Resisting Steels- Classification
AWS A5.10/A5.10M	(2021) Welding Consumables - Wire Electrodes, Wires and Rods for Welding of Aluminum and Aluminum-Alloys - Classification
AWS A5.18/A5.18M	(2021) Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc

	Welding
AWS A5.22/A5.22M	(2012) Specification for Stainless Steel Flux Cored and Metal Cored Welding Electrodes and Rods
AWS A5.32/A5.32M	(2021) Welding Consumables-Gases and Gas Mixtures for Fusion Welding and Allied Processess
AWS C5.5/C5.5M	(2003) Recommended Practices for Gas Tungsten Arc Welding
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D10.4	(1986; R 2000) Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing
AWS D10.7/D10.7M	(2008) Guide for the Gas Shielded Arc Welding of Aluminum and Aluminum Alloy Pipe
AWS D10.10/D10.10M	(2021) Recommended Practices for Local Heating of Welds in Piping and Tubing
AWS D10.11M/D10.11	(2007) Guide for Root Pass Welding of Pipe Without Backing
AWS D10.12M/D10.12	(2000) Guideline for Welding Mild Steel Pipe
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors
AWS WHB-4.9	(2010) Welding Handbook, Volume 4 - Materials and Applications Part 1
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

1.2 DEFINITIONS

Definitions must be in accordance with AWS A3.0M/A3.0 except as follows:

a. Weld slag is defined as the crystalline residue remaining on the weld surface following a weld procedure which uses flux as a shielding method.

b. POL service piping consists of piping and components used for petroleum, oil and lubricants (POL) under pressure or gravity force including modifications to existing hydrant fueling systems.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Welding Procedure Specifications (WPS); G, DO

Welder Performance Qualification (WPQ); G, DO

Procedure Qualification Record (PQR); G, DO

Welding Operations; G, DO

SD-02 Shop Drawings

POL Service Piping; G, DO

SD-06 Test Reports

Welding Reports

Examinations, Inspections and Tests; G, RO

SD-07 Certificates

Qualifications; G, RO

1.4 GENERAL REQUIREMENTS

This section covers the welding of Petroleum, Oil and Lubricant (POL) Service systems. Deviations from applicable codes, approved procedures, and approved detail drawings will not be permitted without prior written approval by the Contracting Officer. Materials or components with welds made offsite will not be accepted if the welding does not conform to the requirements of this specification, unless otherwise specified. Procedures must be developed by the Contractor for welding all metals included in the work. Welding must not be started until welding procedures, welders, and welding operators have been qualified. Qualification testing must be performed by an approved testing laboratory, or by the Contractor if approved by the Contracting Officer. Costs of such testing must be borne by the Contractor. The Contracting Officer must be notified at least one week in advance of the time and place of the tests. If the Contracting Officer elects to witness the tests, the qualification tests must be performed at or near the worksite. The Contractor must maintain current records of the test results obtained in the welding procedure, welding operator, welder performance qualifications, and nondestructive examination (NDE) procedures readily available at the site for examination by the Contracting Officer. The procedures for making transition welds between different materials or between plates or pipes of different wall thicknesses must be qualified. Unless otherwise specified, the choice of welding process must be the responsibility of the Contractor. It should be noted that ASME B31.3 incorporates by reference, other requirements of ASME Section V, Section IX and specific AWS requirements.

1.5 PERFORMANCE

The Contractor will be responsible for the quality of all joint preparation, welding, and examination. All materials used in the welding

operations must be clearly identified and recorded. The inspection and testing defined in this specification are minimum requirements. Additional inspection and testing must be the responsibility of the Contractor when he deems it necessary to achieve the quality required.

1.6 QUALIFICATIONS

Welding procedures, welders, and welding operators previously qualified by test may be accepted for the work without requalification, provided that all of the following conditions are fulfilled:

a. Copies of the welding procedure specifications (WPS), the procedure qualification record (PQR) record, and the welder performance qualification (WPQ) are submitted and approved in accordance with paragraph SUBMITTALS.

b. Testing was performed by an approved testing laboratory or approved technical consultant or by the Contractor's approved quality assurance organization.

c. The welding procedures, welders, and welding operators were qualified in accordance with ASME B31.3 and base materials, filler materials, electrodes, equipment, and processes conformed to the applicable requirements of this specification.

d. The requirements of paragraph RENEWAL OF QUALIFICATION below are met and records showing name of employer and period of employment using the process for which qualified are submitted as evidence of conformance.

1.6.1 Welding Operations

The Contractor must provide a description of how the critical welding operations will be accomplished. Provide the welding procedures to be used for each operation, the sequence of welding to minimize heat distortion, sequence of welding piping sections both in the trench and outside, machine welding if used, and multiple welders on same pipe weld. Submit detailed procedures which define methods of compliance to contract drawings and specifications.

1.6.2 Welding Procedure Specification and Procedure Qualification Records

The Contractor must record in detail and must qualify the Welding Procedure Specifications for every proposed welding procedure. Qualification for each welding procedure must conform to the requirements of ASME B31.3 and to this specification. The welding procedures must specify back purge gas requirements, end preparation for butt welds including cleaning, alignment, and root openings. Preheat, interpass temperature control, and postheat treatment of welds must be as required by approved welding procedures, unless otherwise indicated or specified. Copies of the welding procedure specifications and weld procedure qualification record results for each type of welding required must be submitted in accordance with paragraph SUBMITTALS. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds. Welding procedures must be identified individually and must be referenced on the POL service piping shop drawings. Submit detail drawings showing location, length, and type of welds; and indicating preweld and postweld heat treatment and NDE as required. The drawings must show the welding procedure specification

(WPS) to be used at each weld location.

1.6.3 Welder and Welding Operator Performance

Each welder and welding operator assigned to work must be qualified in accordance with ASME B31.3.

1.6.3.1 Certification

Before assigning welders or welding operators to the work, the Contractor must provide the Contracting Officer with their names together with certification that each individual is performance-qualified as specified. The certification must state the type of welding and positions for which each is qualified, the code and welding procedure specification under which each is qualified, date qualified, and the firm and individual certifying the qualification tests. The Contractor must provide a summary table showing all welders and the WPS with which they are qualified to weld.

1.6.3.2 Identification

Each particular weld must be identified with the personal number, letter, or symbol assigned to each welder or welding operator. To identify welds, written records indicating the location of welds made by each welder or welding operator must be submitted, and each welder or welding operator must apply the personal mark adjacent to the welds using a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Contracting Officer that do not deform the metal. Identification by die stamps or electric etchers will not be allowed.

1.6.3.3 Renewal of Qualification

Requalification of a welder or welding operator must be required under any of the following conditions:

a. When a welder or welding operator has not used the specific welding procedure for a period of 3 months; the period may be extended to 6 months if the welder or welding operator has been employed on another welding procedure.

b. When a welder or welding operator has not welded with any procedure during a period of 3 months, all the personal qualifications must be considered expired, including any extension by virtue of a. above.

c. There is specific reason to question the person's ability to make welds that will meet the requirements of the specifications.

d. The welder or welding operator was qualified by an employer, other than those firms performing work under this contract, and a qualification test has not been taken within the preceding 12 months.

e. Renewal of qualification for a specific welding procedure under conditions a., b., and d., above, needs to be made on only a single test joint or pipe of a thickness, position, or material required by the welding procedure specifications to reestablish the welder's or welding operator's qualification for the previous qualification.

1.6.4 Test Reports

Test reports must consist of the following.

a. Records made by the AWS certified inspector for all duties performed per paragraph 4.2 of AWS QC1.

b. All NDE (radiograph) reports with unique weld ID for each weld tested.

c. "Weld Maps". These maps/drawings correlate the shop drawings submitted to the NDE reports. The NDE report that shows a weld number as acceptable is correlated with weld number on the drawings.

d. Provide the location of each weld, what procedure was used, which welder did the weld, the results of the visual test, and the results of the NDE.

1.6.5 Inspection and NDE Personnel

Contractor must provide a commercially independent organization for all weld examinations. All inspection and NDE personnel must be qualified in accordance with the following requirements. The contractor must submit the qualifications of all the testing personnel that will perform all field tests for review by the Contracting Officer. The qualifications of all personnel on the job site that will perform welding inspections and NDE must be submitted for approval. All inspectors and NDE personnel must have a minimum of one year experience inspecting the piping material being used and five years in military or commercial aircraft hydrant fueling systems or truck fueling systems, petroleum refineries, power generating plants, or chemical process plants.

1.6.5.1 Inspector Certification

Visual welding inspectors must be qualified in accordance with AWS QC1.

1.6.5.2 NDE Personnel

NDE personnel must be certified Level II in accordance with ASME Section V, ASME B31.3 and ASNT SNT-TC-1A for each NDE procedure he is required to use, and a written procedure for the control and administration of NDE personnel training, examination, and certification must be established. The procedures must be based on appropriate specific and general guidelines of training and experience recommended by ASNT SNT-TC-1A. Should the NDE examiner also be a welder, that individual is disqualified from examining their own work.

1.7 DELIVERY, STORAGE, AND HANDLING

All filler metals, electrodes, and other welding materials must be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages must be properly labeled and designed to give maximum protection from moisture and to insure safe handling.

1.7.1 Material Control

Materials must be stored in a controlled access and clean, dry area that is weathertight and is maintained at a temperature recommended by the manufacturer. The materials must not be in contact with the floor and must be stored on wooden pallets or cribbing.

1.7.1.1 Damaged Containers

Low-hydrogen steel electrodes must be stored in their sealed shipping container. If the seal is damaged during shipment or storage, and the damage is not immediately detected, the covered electrodes in that container must be rebaked in accordance with the manufacturer's instructions prior to issuance or must be discarded. If a container is damaged in storage and the damage is witnessed, the electrodes from that container must be immediately placed in a storage oven. The storage oven temperature must be as recommended by the manufacturer or the welding material specification.

1.7.1.2 Partial Issues

When a container of covered electrodes is opened and only a portion of the content is issued, the remaining portion must, within 1/2-hour; be placed in a storage oven.

1.7.2 Damaged Materials

Materials which are damaged must be discarded. Covered electrodes which are oil or water-soaked, dirty, or on which the flux has separated from the wire must be discarded.

1.8 SYMBOLS

Symbols must be in accordance with AWS A2.4.

1.9 SAFETY

Safety precautions must conform to AWS Z49.1.

PART 2 PRODUCTS

2.1 WELDING MATERIALS

Welding materials for carbon steel, stainless steel and aluminum must comply with AWS WHB-4.9. Welding equipment, electrodes, welding wire, shielding and backing gas, and fluxes must be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures. All field girth root pass welds must be made with non-covered electrodes or welding wire. All root passes must be made with shielding and backing gas. External welds on the pipe such as attaching pipe supports may be made with covered electrodes or welding wire. Electrodes, welding wire or fluxes must be in accordance with Table 1. Welding materials for aluminum and aluminum alloy must comply with AWS D10.7/D10.7M.

TABLE I

AWS	Process	Alloy	Consumable	Use
			(Examples) (1)	
AWS A5.1/A5.1M	SMAW	Low Carbon	E7018	Fill

TABLE I				
AWS	Process	Alloy	Consumable	Use
			(Examples) (1)	
AWS A5.4/A5.4M	SMAW	Stainless	E308L, E309L	Fill
AWS A5.3/A5.3M	SMAW	Aluminum		Fill
AWS A5.9/A5.9M	GTAW	Stainless	ER308L,ER309L	Root and Fill
AWS A5.10/A5.10M	GTAW	Aluminum		Root and Fill
AWS A5.18/A5.18M	GTAW	Low Carbon	E70S-3,E70S-6	Root and Fill
AWS A5.22/A5.22M	GTAW	Stainless	E308LT1-1	Root (Backing and Shielding Gas Required)
AWS A5.32/A5.32M	GTAW	All		Shielding Gas
Note(1): The consumable material designations shown are examples only and are not intended to limit the Contractor's selection of consumable materials.				

PART 3 EXECUTION

3.1 WELDING OPERATIONS

Welding must be performed in accordance with qualified procedures using qualified welders and welding operators. Welding must not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The Contracting Officer must determine when weather or working conditions are unsuitable for welding. Welding of hangers, supports, and plates to structural members must conform to Section 05 05 23.16 STRUCTURAL WELDING.

Welding must be performed in accordance with ASME B31.3 and the applicable portions of AWS D10.4, AWS D10.7/D10.7M, AWS D10.10/D10.10M, AWS D10.11M/D10.11, AWS D10.12M/D10.12, and AWS C5.5/C5.5M.

All joints unless indicated otherwise, in carbon steel, aluminum and stainless steel piping systems must be welded. Unless otherwise approved, all girth welds must be complete penetration groove welds made in accordance with qualified welding procedures. The root pass on stainless steel, aluminum, and carbon steel pipe must be by the GTAW process.

a. Weld Preparation must comply with the requirements of ASME B31.3 and the qualified Welding Procedure Specification. The use of "rice paper" as purge blocks is not permitted. Contractor must submit alternate method for approval.

b. Backing Rings. The use of backing rings for making or repairing welds will not be permitted.

3.1.1 Base Metal Preparation

Oxy-fuel cutting must not be used on austenitic stainless steel or nonferrous materials.

Mechanical grinding of thermal cut ends must be used to remove the heat affected area but should be limited to maximum 1/8 inch.

3.1.2 Weld Joint Fit-Up

Parts that are to be joined by welding must be fitted, aligned, and retained in position during the welding operation by the use of bars, jacks, clamps, or other mechanical fixtures. End welds must be properly aligned prior to welding in accordance with Chapter V of ASME B31.3. All socket-welded joints must be properly fitted with gaps between the pipe and the bottom of the socket in accordance with ASME B31.3. Contractor must implement a program to ensure gaps are properly measured and documented. Welded temporary attachments must not be used except when it is impractical to use mechanical fixtures. When temporary attachments are used, they must be the same material as the base metal, and must be completely removed by grinding or thermal cutting after the welding operation is completed. If thermal cutting is used, the attachment must be cut to not less than 1/4 inch from the member and the balance removed by grinding. After the temporary attachment has been removed, the area must be visually examined.

3.1.3 Butt Weld Joint Spacing

Butt weld joints must be spaced a minimum of 6 inches apart. Measurement must be taken from the toe of the first weld to the toe of the second weld. The measurement must be taken at the closest point between the welds when visually inspected. If spacing is not possible due to existing conditions, a reduction in spacing to not less than 2 inches may be made.

3.1.4 Preheat and Interpass Temperatures

Preheat temperatures must meet the requirements specified by ASME B31.3. However, in no case will the preheat be below 50 degrees F for ferritic steel or austenitic stainless steel, or 32 degrees F for nonferrous alloys. The maximum interpass temperatures must not exceed 300 degrees F for austenitic stainless steels, nickel alloys, and copper alloys; and 500 degrees F for carbon steels. Preheat techniques must be such as to ensure that the full thickness of the weld joint preparation or adjacent base material, at least 3 inches in all directions, is at the specified temperature. Preheating by induction or resistance methods is preferred. When flame heating is used, only a neutral flame must be employed. Oxy-fuel heating must not be used on austenitic stainless steel; however, air-fuel heating is acceptable if controlled to ensure that the surface temperature does not exceed 150 degrees F. Interpass temperatures must be checked on the surface of the component within one inch of the weld groove and at the starting location of the next weld pass, and for a distance of about 6 inches ahead of the weld, but not on the area to be welded.

3.1.5 Production Welding Instructions

a. Welding must not be done when the ambient temperature is lower than 0 degrees F.

b. Welding is not permitted on surfaces that are wet or covered with ice,

when snow or rain is falling on the surfaces to be welded, or during periods of high winds, unless the welders and the work are properly protected.

c. Gases for purging and shielding must be welding grade and must have a dew point of minus 40 degrees F or lower.

d. Back purges are required for austenitic stainless steels and nonferrous alloys welded from one side and must be set up such that the flow of gas from the inlet to the outlet orifice passes across the area to be welded. The oxygen content of the gas exiting from the purge vent must be less than 2 percent prior to welding. The flow rate must be that required by the approved weld procedure specification.

e. The purge on groove welds must be maintained for at least two passes or 3/16 inch whichever is greater.

f. Removable purge dam materials must be made of expandable or flexible plugs, such as Plexiglas, plywood (which must be dry when used). Wood dams must be kiln-dried quality. Purge dams must not be made of polyvinyl alcohol.

g. Any welding process which requires the use of external gas shielding must not be done in a draft or wind unless the weld area is protected by a shelter. This shelter must be of material and shape appropriate to reduce wind velocity in the vicinity of the weld to a maximum of 5 mph (440 fpm).

h. Tack welds to be incorporated in the final welds must have their ends tapered by grinding or welding technique. Tack welds that are cracked or defective must be removed and the groove must be retacked prior to welding. Temporary tack welds must be removed, the surface ground smooth, and visually inspected. For low-alloy and hardenable high-alloy steels, the area must be magnetic particle examination inspected.

i. Grinding of completed welds is to be performed only to the extent required for NDE, including any inservice examination, and to provide weld reinforcement within the requirements of ASME B31.3. If the surface of the weld requires grinding, reducing the weld or base material below the minimum required thickness must be avoided. Minimum weld external reinforcement must be flush between external surfaces.

j. Each qualified welder must be assigned an identification symbol. All welds must be permanently marked with the symbol of the individual who made the weld.

k. Direct welded connection of carbon steel and stainless steel must not be made. See Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

3.1.6 Postweld Heat Treatment

a. When required postweld heat treatment must be performed in accordance with ASME B31.3. Temperatures for local postweld heat treatment must be measured continuously by thermocouples in contact with the weldment.

b. Postweld heat treatment of low-alloy steels, when required, must be

performed immediately upon completion of welding and prior to the temperature of the weld falling below the preheat temperature. However, postweld heat treatment may be postponed after the completion of the weld, if, immediately after the weld is completed, it is maintained at a minimum temperature of 300 degrees F or the preheat temperature, whichever is greater, for 2-hours per one inch of weld thickness.

3.2 EXAMINATIONS, INSPECTIONS AND TESTS

Weld inspection and NDE must be performed by the Contractor to detect surface and internal discontinuities in completed welds. The services of a qualified commercial inspection or testing laboratory or technical consultant meeting the requirements of paragraph INSPECTION AND NDE PERSONNEL, approved by the Contracting Officer, must be employed by the Contractor. All completed welds must be visually inspected in accordance with the visual inspection requirements of ASME B31.3 and AWS D1.1/D1.1M. Radiographic, Liquid penetrant, or Magnetic particle examination must be required as indicated below. When in-process weld quality control is required for tie-in welds, it must be performed in accordance with ASME B31.3. When inspection and testing indicates disqualifying defects in a weld joint, the weld must be repaired by a qualified welder in accordance with paragraph CORRECTIONS AND REPAIRS. The Contractor must submit weld inspection and NDE field testing reports to the Contracting Officer.

The person performing the weld inspection must perform the following:

a. Verify that the base materials and consumable welding materials conform to the specifications and that welding filler metals used are as specified for each base material.

b. Verify that the welding equipment to be used for the work is appropriate for use with the welding procedure specification and has the capability to meet the applicable requirements of the welding procedure.

c. Verify that only approved or qualified welding procedures are used for the work.

d. Verify that the edge preparation or joint geometry meet the requirements of the welding procedure and drawings.

e. Verify that the specified filler metals are used and that filler metals are maintained in proper condition, per requirements, or as recommended by the manufacturer.

f. Verify that the technique and performance of each welder, welding operator, and tack welder are as specified.

g. Verify that the work conforms to requirements of the applicable standards, drawings, or other documents.

h. Verify that the work inspected is identified and documented in accordance with specified requirements.

i. Prepare clear and concise reports and verify that records of the results of examinations are maintained.

j. Verify the approved WPS pre-heat and post heat procedures are being used.

Welders found making defective welds must be removed from the work or must be required to be requalified in accordance with ASME B31.3.

3.2.1 Visual Inspection

Weld joints must be inspected visually as follows:

a. Before welding - for compliance with requirements for joint preparation, alignment and fit-up, and cleanliness in accordance with ASME B31.3.

b. During welding - for cracks and conformance to the approved welding procedure only when in-process weld quality control is required by ASME ASME B31.3.

c. After welding - for cracks, contour and finish, bead reinforcement, undercutting, overlap, weld slag on the interior of the pipe and size of welds in accordance with ASME B31.3 and AWS D1.1/D1.1M. Visual examination of the interior of the pipe may be performed by any of the remote means allowed by ASME BPVC SEC V, visual inspection. Visual examination of the weld must be performed prior to any other NDE examinations as required by this specification.

3.2.2 NDE Testing Frequency

All pipe field welds, including high point vent pipe tees, insert butt welded weld-o-lets, and low point drain pipe, must be examined by radiographic methods to determine conformance to the paragraph ACCEPTANCE STANDARDS. All socket welds and sock-o-lets or weld-o-lets to pipe welds must be examined with either magnetic particle or liquid penetrant methods, in addition to the visual examinations. The services of a qualified commercial or testing laboratory approved by the Contracting Officer must be employed by the Contractor for testing of piping welds. Costs of testing, including retesting of repaired welds, must be borne by the Contractor.

a. Provide 100 percent radiographic testing for all underground piping.

b. Provide select radiographic testing in accordance with ASME B31.3 for all aboveground piping. The inspection must include an examination of welds made by each welding operator or welder. Not less than 30 percent of total welds shall be examined. If the testing reveals that any welds fail to meet minimum quality requirements, an additional percent of the welds in that same group must be inspected in accordance with ASME B31.3. If all of the additional welds inspected meet the quality requirements, the entire group of welds represented must be accepted and the defective welds must be repaired. If any of the additional welds inspected also fail to meet the quality requirements, that entire group of welds must be rejected. The rejected welds must be removed and rewelded, or the rejected welds must be 100 percent inspected and all defective weld areas removed and rewelded.

3.2.3 NDE Testing

NDE must be as required by ASME B31.3 and in accordance with written

procedures. Procedures for radiographic, liquid penetrant, and magnetic particle tests and methods must conform to ASME BPVC SEC V. Only Radiography are acceptable test methods for butt welded joints. The approved procedure must be demonstrated to the satisfaction of the Contracting Officer. In addition to the information required in ASME BPVC SEC V, the written procedures must include the timing of the NDE in relation to the welding operations and safety precautions.

The services of a commercially independent qualified testing agency approved by the Contracting Officer must be employed by the Contractor for testing of piping welds. Costs of testing, including retesting of repaired welds, must be borne by the Contractor. Weld ripples or surface irregularities that might mask or be confused with the radiographic image of any objectionable defect must be removed by grinding , or other suitable mechanical means. The weld surface must be merged smoothly with the base metal surface.

3.2.4 Inspection and Tests by the Government

The Government may perform inspection and supplemental nondestructive or destructive tests as deemed necessary. The cost of supplemental NDE will be borne by the Government. The correction and repair of defects and the reexamination of weld repairs must be performed by the Contractor at no additional cost to the Government. Inspection and tests will be performed as required for visual inspection and NDE, except that destructive tests may be required also. When destructive tests are ordered by the Contracting Officer and performed by the Contractor and the specimens or other supplemental examinations indicate that the materials and workmanship do not conform to the contract requirements, the cost of the tests, corrections, and repairs must be borne by the Contractor. When the specimens or other supplemental examinations of destructive tests indicate that materials or workmanship do conform to the specification requirements, the cost of the tests and repairs will be borne by the Government. When destructive tests are made, repairs must be made by qualified welders or welding operators using welding procedures which will develop the full strength of the members cut. Welding must be subject to inspection and tests in the mill, shop, and field. When materials or workmanship do not conform to the specification requirements, the work may be rejected at any time before final acceptance of the system containing the weldment.

3.3 ACCEPTANCE STANDARDS

Acceptance standards must be in accordance with ASME B31.3 paragraph 341.3.2, Chapter VI in addition to the following specified items.

Interpretation of test results and limitations on imperfections in welds must comply with the requirements of 100 percent radiography, per ASME B31.3, paragraph 341.3.2, Chapter VI. For hydrant systems and stainless steel systems the evaluation must be based on severe cyclic conditions in addition to the following-specified items.

3.3.1 Visual

The following indications are unacceptable:

Weld Slag on the interior of the pipe.

3.3.2 Magnetic Particle Examination

The following relevant indications are unacceptable:

a. Any linear indications.

b. Rounded indications with dimensions greater than 3/16 inch.

c. Four or more rounded indications in a line separated by 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 6 square inches of surface with the major dimension of this area not to exceed 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.

3.3.3 Liquid Penetrant Examination

Indications with major dimensions greater than 1/16 of an inch must be considered relevant. The following relevant indications are unacceptable:

a. Any cracks or linear indications.

b. Rounded indications with dimensions greater than 3/16 inch.

c. Four or more rounded indications in a line separated by 1/16 inch or less edge-to-edge.

d. Ten or more rounded indications in any 6 square inches of surface with the major dimension of this area not to exceed 6 inches with the area taken in the most unfavorable location relative to the indications being evaluated.

3.4 CORRECTIONS AND REPAIRS

Disqualifying defects must be removed and repaired as specified in ASME B31.3 unless otherwise specified. Disqualifying defects discovered between weld passes must be repaired before additional weld material is deposited. After defect removal is complete and before rewelding, the area must be examined by the same test method which first revealed the defect to ensure that the defect has been eliminated. After rewelding, the repaired area must be reexamined by the same test method originally used for that area. Any indication of a defect must be regarded as a defect unless reevaluation by NDE or by surface conditioning shows that no disqualifying defects are present.

3.4.1 Defect Removal

Defective or unsound weld joints must be corrected by removing and replacing the entire weld joint, or for the following defects corrections must be made as follows:

a. Excessive Convexity and Overlap: Reduce by removal of excess metal.

b. Excessive Concavity of Weld, Undersized Welds, Undercutting: Clean and deposit additional weld metal.

c. Excessive Weld Porosity, Inclusions, Lack of Fusion, Incomplete Penetration: Remove defective portions and reweld.

d. Cracks or liner indications in Weld or Base Metal: Remove crack throughout its length, including sound weld metal for a distance of twice the thickness of the base metal or two inches, whichever is less, beyond each end of the crack, followed by the required rewelding. Complete removal must be confirmed by magnetic particle inspection for carbon steel or liquid penetrant inspection for stainless steel. Inspection procedures must comply with the requirements of ASME B31.3.

e. Poor Fit-Up: Cut apart improperly fitted parts, and reweld.

3.4.1.1 Methods of Defect Removal

The removal of weld metal or portions of the base metal must be done preferably by chipping, grinding, sawing, machining, or other mechanical means. Defects also may be removed by thermal cutting techniques. If thermal cutting techniques are used, the cut surfaces must be cleaned and smoothed by mechanical means to remove the heat affected zone. In addition, a maximum of 1/8-inch of metal must be removed by mechanical means from the cut surfaces of stainless steel.

Wherever a defect is removed, and repair by welding is not required, the affected area must be blended into the surrounding surface eliminating sharp notches, crevices, or corners.

3.4.1.2 Rewelding

Repair welds must be made using an electrode or filler wire smaller than that used in making the original weld. Rewelding must be done using qualified welding procedures. The surface must be cleaned before rewelding. Repair welds must meet the requirements of this specification.

3.4.1.3 Peening or Caulking

The use of force (peening) or foreign materials to mask, fill in, seal, or disguise any welding defects must not be permitted.

3.5 MAINTAINING CLEANLINESS OF PIPING

The Contractor must keep the interior and ends of all new piping affected by the Contractor's operations thoroughly cleaned of foreign matter and water before and after being installed. Piping systems must be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of piping and fittings must be closed so that no water or other foreign substance will enter the pipes or fittings. Piping must be inspected before placing into position. The interior of each length of pipe must be cleaned after welding; A swab, with a leather or canvas belt disc to fit the inside diameter of pipe, must be pulled through each length of pipe after welding in place. It must be the Contractor's responsibility for insuring that the interior of the piping is free of foreign matter including weld slag when it is connected into the system.

3.6 COMMISSIONING

For commissioning of POL service piping systems see Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

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DIVISION 33 - UTILITIES

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SECTION 33 52 40

FUEL SYSTEMS PIPING (NON-HYDRANT)
11/18, CHG 2: 11/20

PART 1 GENERAL

1.1 SUMMARY

This section defines the requirements for pipe, piping components, and valves as related to an non-hydrant, non-service station, fuel distribution system. Such systems include, but are not limited to: truck off-loading receipt, transfer pipeline, product recovery, and other miscellaneous piping systems. Provide the entire fuel distribution system as a complete and fully operational system. Size, select, construct, and install equipment and system components to operate together as a complete system. Substitutions of functions specified herein will not be acceptable. Coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system. System components and piping (aside from the vent piping) specified herein must be designed to handle a working pressure of 275 psig at 100 deg F. Components specified herein must be compatible with the fuel to be handled. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between -20 degrees F and 120 degrees F.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 1110	(2013; R 2018) Recommended Practice for the Pressure Testing of Steel Pipelines for the Transportation of Gas, Petroleum Gas, Hazardous Liquids, Highly Volatile Liquids, or Carbon Dioxide
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API RP 2009	(2002; R 2007; 7th Ed) Safe Welding, Cutting, and Hot Work Practices in Refineries, Gasoline Plants, and Petrochemical Plants
API RP 2200	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API STD 600	(2015) Steel Gate Valves-Flanged and Butt-welding Ends, Bolted Bonnets

API STD 608	(2012) Metal Ball Valves - Flanged, Threaded, And Welding End
API Spec 6D	(June 2018, 4th Ed; Errata 1 July 2018; Errata 2 August 2018) Specification for Pipeline and Piping Valves
API Spec 6FA	(1999; R 2006; Errata 2006; Errata 2008; R 2011) Specification for Fire Test for Valves
API Std 594	(2017) Check Valves: Flanged, Lug, Wafer and Butt-Welding
API Std 607	(2016) Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2018) Factory-Made Wrought Buttwelding Fittings
ASME B16.11	(2022) Forged Fittings, Socket-Welding and Threaded
ASME B16.20	(2017) Metallic Gaskets for Pipe Flanges
ASME B16.21	(2021) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.34	(2021) Valves - Flanged, Threaded and Welding End
ASME B18.2.1	(2012; R 2021) Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.3	(2022; Errata 2023) Process Piping

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A182/A182M	(2023) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A269/A269M	(2022) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A312/A312M	(2022a) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A358/A358M	(2019) Standard Specification for Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications
ASTM A403/A403M	(2022b) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A961/A961M	(2023) Standard Specification for Common Requirements for Steel Flanges, Forged Fittings, Valves, and Parts for Piping Applications
ASTM D229	(2019) Standard Test Methods for Rigid Sheet and Plate Materials Used for Electrical Insulation
ASTM D1418	(2010; R 2016) Standard Practice for Rubber and Rubber Lattices - Nomenclature
ASTM D3308	(2012; R 2017) Standard Specification for

	PTFE Resin Skived Tape
ASTM F336	(2002; R 2023) Standard Practice for Design and Construction of Nonmetallic Enveloped Gaskets for Corrosive Service
ASTM F436	(2011) Hardened Steel Washers

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1629	(2013) Rubber and Latices - Nomenclature

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024) Flammable and Combustible Liquids Code
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 77	(2024) Recommended Practice on Static Electricity
NFPA 407	(2022; TIA 21-1) Standard for Aircraft Fuel Servicing
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 5/NACE No. 1	(2007) White Metal Blast Cleaning

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3275	(2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant

SAE J514 (2012) Hydraulic Tube Fittings

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-13789 (1999; Rev E; Notice 1 2008; Notice 2 1016; Notice 3 2021) Strainers, Sediment: Pipeline, Basket Type

UL SOLUTIONS (UL)

UL 971 (1995; Reprint Mar 2006) UL Standard for Safety Nonmetallic Underground Piping for Flammable Liquids

1.3 ADMINISTRATIVE REQUIREMENTS

Design conditions must be as specified in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT). Refer to Section 01 78 23 OPERATION MAINTENANCE DATA.

1.4 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work Plan; G, RO

Hydrotesting Plan; G, DO

Quality Assurance Plan; G, RO

SD-02 Shop Drawings

Grounding and Bonding

Pipe Supports; G, DO

SD-03 Product Data

Stainless Steel Piping; G, DO

Flexible Non-Metallic Pipe; G, DO

Fittings; G, DO

Insulating Flange Kits; G, DO

Lightning Surge Arrester; G, DO

Bolts, Nuts And Washers; G, DO

Flange Protectors; G, DO

Ball Valves; G, DO

V Port Ball Valve; G, DO

Plug (Double Block and Bleed) Valves; G, DO

Electric Valve Actuator; G, DO

Swing Check Valves; G, DO

Silent Check Valves; G, DO

Thermal Relief Valve; G, DO

Mechanically Adjustable Segmented Elastomeric Seal; G, DO

Pipe Sleeves; G, DO

Strainers; G, DO

Sample Connections; G, DO

Sight Flow Indicators; G, DO

Flexible Hose Connectors; G, DO

Automatic Air Vent; G, DO

Buried Utility Tape; G, RO

Pipeline Markers; G, RO

Flange Gaskets, Non-Metallic, Non-Electrically Isolating; G, DO

Flange Gaskets, Metallic; G, DO

Heat Trace; G, DO

Double Wall Piping; G, DO

Tank Overfill Prevention Valve (Pumped Fuel Receipt); G, DO

Pipe Insulation Systems; G, DO

SD-06 Test Reports

Pneumatic Test; G, DO

Hydrostatic Test; G, DO

Performance Testing; G, DO

SD-07 Certificates

Contractor Qualifications; G, RO

System Supplier; G, RO

Pipeline Inventory; G, RO

Qualifications of Owner's Inspector; G, RO

Survey Final Elevations; G, RO

Demonstrations

SD-08 Manufacturer's Instructions

SD-10 Operation and Maintenance Data

Insulating Flange Kits; G, RO

Lightning Surge Arrester; G, RO

Ball Valves; G, RO

V Port Ball Valve; G, RO

Plug (Double Block and Bleed) Valves; G, RO

Electric Valve Actuator; G, RO

Swing Check Valves; G, RO

Thermal Relief Valve; G, RO

Mechanically Adjustable Segmented Elastomeric Seal; G, RO

Strainers; G, RO

Sample Connections; G, RO

Sight Flow Indicators; G, RO

Automatic Air Vent; G, RO

1.5 QUALITY ASSURANCE

1.5.1 Contractor Qualifications

Each installation Contractor must have successfully completed at least 3 projects of the similar scope and the same size or larger within the last 6 years. Each installation Contractor must demonstrate specific installation experience in regard to the specific system installation to be performed. Each installation Contractor must have taken, if applicable, manufacturer's training courses on the installation of piping and must meet the licensing requirements in the state. Experience must include the erection of piping systems in compliance with the requirements of ASME B31.3, and NFPA 30. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. Provide in the letter evidence of prior manufacturer's training and state licensing.

1.5.2 System Supplier

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

1.5.3 Work Plan

Submit a comprehensive work plan that provides sufficient detail to demonstrate a thorough understanding of the project. Document that all components to be provided will function together and produce the result expected by the Government. Include any proposed dates for piping system shutdowns as well as the Contractor's ability to complete the work within the allotted shutdown periods. Show proposed dates and nature of piping system operations required of the Government. Include a list of manpower, spare piping and system component that will be on hand for each phase of the work. Describe, in detail, the means of:

a. Coordinating work with Government and third parties.

b. Preparing for safe piping repair work.

c. Pneumatic pressure testing new piping sections.

d. Hydrostatic pressure testing new piping sections.

e. Purging piping.

f. Vapor monitoring.

g. Preparations for containing and disposing of residual fuel.

h. Cutting, sealing, and welding into existing piping systems.

i. Welding tie-ins in place.

j. Examining repair section tie-in welds.

k. Collecting, storing and disposing of waste fuel generated during work.

1.5.4 Hydrotesting Plan

The Contractor must submit a detailed written plan covering all aspects of the pipeline hydrostatic testing operations, including procedures and sequencing of testing, segments of piping to be tested, fluid to be used during testing, equipment removal and isolation, hydrostatic testing pressures, safety protocols, etc.

1.5.5 Design Data

1.5.5.1 Pipeline Inventory

Fuel system volume must be calculated using as constructed pipe lengths, internal diameters, fittings, and components. Totals must be provided for all items containing fuel with the exception of tanks which is covered by other specifications. A certified pipeline inventory - a detailed list with sizes, lengths, quantity, and volumes must be provided for the systems in this project. Such systems include, but are not limited to:

marine receipt, pipeline receipt, truck off-loading receipt, pump house, pump pad, truck loading, marine loading, transfer pipeline, product recovery, and other miscellaneous piping systems.

1.5.6 Material and System Components Qualifications

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

1.5.7 Nameplates

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

1.5.8 Delivery, Storage, and Handling

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT). If fuel is used for hydrotesting , comply with all the requirements in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

PART 2 PRODUCTS

2.1 ELECTRICAL WORK

2.1.1 General

Motors, manual or automatic motor control system components except where installed in motor control centers, and protective or signal devices required for the operation specified herein must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM , Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.1.2 Grounding and Bonding

Ground and bond as indicated on the drawings and in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.2 MATERIALS

Pipe and fittings in contact with fuel must be stainless steel, interior epoxy coated carbon steel, or interior uncoated carbon steel as indicated on the drawings or as specified herein. No zinc coated metals, brass, bronze or other copper bearing alloys must be used in contact with the fuel. Material for manual valves must be as specified hereinafter. Do not use aluminum valves.

2.2.1 Types of Fuel

Components must be suitable for use with engine oil and DS1/2 diesel fuel; specific gravity 0.88 at 60 degrees F; viscosity 3 CS at 60 degrees F; Reid Vapor pressure less than .3 psi, MIL-DTL-5624.

2.2.2 Stainless Steel Piping

a. Piping:

(1) ASTM A358/A358M, Grade 304L, Class 1 or Class 3 with supplementary requirements of S1, S2 and S3, or ASTM A312/A312M Type 304L, seamless (only). Any agreements between the purchaser and the manufacturer or supplier as referenced in the applicable ASTM must include the Contracting Officer as a party to the agreement. All longitudinal piping welds will receive 100 percent radiographic inspection, 100 percent liquid penetrant inspection, 100 percent visual inspection and all tests as required by the applicable ASTM Standard. All other welds must be inspected per Section 33 52 23.15 POL SERVICE PIPING WELDING. ASTM A312/A312M seamless piping must be provided with a minimum schedule 10S wall thickness for pipe 8 inches and larger; minimum schedule 40S for pipe smaller than 8 inches (except for threaded pipe which must be minimum Schedule 80S).

(2) Pipe Ends: All Piping must be provided with beveled ends per Chapter V, ASME B31.3, and must be shipped with the ends capped.

(3) Factory Testing and Inspection Records: Per Table K341.3.2 of Chapter IX of ASME B31.3, visual, radiographic and liquid penetrant tests must be performed for each section of piping provided as all sections are subjected to cyclic conditions. All testing and inspections records must be submitted to the Contracting Officer and must indicate the pipe mark and installed location of each piping section on the project site. Observation by the Contracting Officer of the manufacturers and the fields testing and inspection procedures must be allowed under this contract. Pipe certification along with pipe markings must be submitted before the pipe arrives on the job site.

(4) Qualifications of Owner's Inspector: Provide a qualified inspector in accordance with Chapter VI of ASME B31.3. to act as the owner's inspector (for the Government) at the pipe manufacturer's facility in addition to the manufacturer's inspector.

(5) Quality Assurance Plan: Submit Quality Assurance Plan for the welding, inspecting and testing of the welded seam pipe.

b. Stainless Steel Control Tubing: Seamless, fully annealed tubing conforming to ASTM A269/A269M, Grade TP316, Rockwell hardness B80 or less. Wall thickness for 1/2-inch tubing to be a minimum of 0.049-inch.

2.2.3 Double Wall Piping

Underground double wall piping shall consist of a stainless steel Type 304L carrier pipe with a nonmetallic fiberglass containment pipe. All stainless steel carrier pipe joints shall be butt welded and radiographed. All containment piping shall be nonmetallic fiberglass conforming to ASTM 2310 and ASTM D2996. The exterior of all containment piping shall be factory coated with a fusion bonded epoxy. The fusion epoxy coating shall be NACE and NAPCA corrosion coating approved. The stainless steel carrier piping shall follow the requirements in 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). The containment piping shall be pneumatically tested at 5psi and shall hold that pressure for 1 hour minimum. All details as shown within the design drawings shall be followed to include

but not be limited to: interior pipe supports, vents, drains and steel end sleeves.

2.2.4 Flexible Non-Metallic Pipe

Piping must conform to UL 971. Piping must be double wall and installed in manufacturers supplied corrugated, flexible, access piping. Flexible Non-Metallic Pipe will only be used for the underground storage tank normal tank vent piping.

2.2.5 Fittings

2.2.5.1 General

Welding ells, caps, tees, reducers, must be of materials compatible for welding to the pipeline in which they are installed, and wall thickness, pressure and temperature ratings of the fittings must be not less than the adjoining pipeline. Unless otherwise specified herein or required by the conditions of installation, all elbows must be the 1.5 diameter (D) type. Miter joints are not acceptable. Make odd angle offsets with pipe bends or elbows cut to the proper angle. Butt weld fittings must be factory-made wrought fittings manufactured by forging or shaping. Fabricated fittings will not be permitted. Welding branch fittings must be insert type suitable for radiographic inspections specified herein.

Make branch connections with butt-welded tees except where the branch is at least two pipe sizes smaller than the run, in which case the branch connection can be made with a forged or seamless branch outlet fitting. The branch outlet fitting must be designed in such a way that the connection can be radiographed. The branch outlet fittings may be a non-radiographicable if: the piping it is connected to is aboveground, the branch outlet size is 2.5 inches or less in diameter, and the branch outlet is located in contained pumphouses, contained truck offloads, contained truck fill stands, and other visibly contained areas equipped with containment curb.

2.2.5.2 Stainless Steel Fittings

a. Fittings 2.5 inches and Larger: Butt weld stainless steel conforming to ASTM A403/A403M, Class WP, Type 304L, seamless or welded, and ASME B16.9 of the same minimum wall thickness as the adjoining pipe. Welded fittings must be tested and inspected the same as the welded seam pipe and meet the same requirements as for the pipe.

b. Fittings 2 inches and Smaller: Forged Type 304 or 304L , butt weld, or socket welded (except flanges, see below). If specifically indicated on drawings, non-flange fittings may be threaded. Socket welded or threaded fittings must be Class 3000 conforming to ASTM A182/A182M and ASME B16.11. Threaded fittings must only be used for above grade applications. Underground and in pits, low point drain pipe, and high point vent pipe must be butt welded.

c. Unions: Conforming to ASTM A182/A182M, Grade 304 or 316.

d. Flanges. Class 150 weld neck, butt weld, forged Type 304 stainless steel flanges conforming to ASTM A182/A182M and ASME B16.5, except flange that are to be connected to pumps must match the pump flanges rating. Threaded and slip-on flanges are not allowed. Flanges to be 1/16-inch raised-face with modified spiral serrated gasket surface

finish, except where required otherwise to match system components furnished. Flange face must be machined to match valves or system components furnished. Match flange face to valves or system components furnished. Flanges must be subjected to the Supplementary Requirements S56, Liquid Penetrant Examination as outlined in ASTM A961/A961M. Detectable flaws will not be acceptable. For flanges 2 inches and smaller located in contained pumphouses, contained truck offloads, contained truck fill stands, and other visibly contained areas the fitting may be forged (socket welded), Class 150, conforming to ASTM A182/A182M and ASME B16.5. In pits, vaults, on thermal relief valve piping for pipeline routes, and other uncontained locations the flanges must be radiographicable, butt welded, weld neck type.

f. Stainless Steel Tube Fittings. Flareless, 316 stainless steel fittings conforming to SAE J514.

2.2.5.3 Flexible Non-Metallic Pipe Fittings

Fittings must conform to UL 971.

2.2.6 Insulating Flange Kits (Electrically Isolating)

Provide ASTM D229 electrical insulating material of 1,000 ohms minimum resistance or 500 Volts per mil (VPM) minimum dielectric strength; material must be resistant to the effects of aviation and non-aviation hydrocarbon fuels. Provide full face insulating gaskets between flanges. Provide full surface 0.03-inch thick wall thickness, spiral-wound mylar insulating sleeves between the bolts and the holes in flanges; bolts may have reduced shanks of a diameter not less than the diameter at the root of threads. Provide 0.125-inch thick high-strength phenolic insulating washers next to flanges and provide flat circular stainless steel washers over insulating washers and under bolt heads and nuts. Provide bolts 0.5-inch longer than standard length to compensate for the thicker insulating gaskets and the washers under bolt heads and nuts. Above grade flanges separated by electrically insulating flange kits must be provided with weatherproof lightning surge arrester devices. The surge arrester must bolt across flanges separated by insulating gasket kits per detail on contract drawings. Provide with flange protector as described in this section. The arrestor must have the following features:

a. Weatherproof NEMA 4 enclosure.

b. Bidirectional and bipolar protection.

c. Constructed of solid state components, no lights, fuses or relays and used without required maintenance or replacement.

d. Withstand unlimited number of surges at 50,000 Amperes.

e. Maximum clamping voltage of 700 Volts based on a IEEE C62.41.2 8x20 microsecond wave form at 50,000 Amperes peak measured at the device terminals (zero lead length).

f. A UL listed arrester for installation in Class 1, Division 1 and Division 2, Group D, hazardous areas.

Install the mounting bracket and leads on the flange side of the bolt insulating sleeve and washer, and size in accordance with this schedule:

Line Size	Bolt Size
2 inch	5/8 inch
2.5 inch	5/8 inch
3 inch	5/8 inch
4 inch	5/8 inch
6 inch	3/4 inch
8 inch	3/4 inch
10 inch	7/8 inch
12 inch	7/8 inch
14 inch	1 inch
16 inch	1 inch
Note: Make allowance for the 1/32-inch thickness of the insulating sleeve around the bolts when sizing the mounting lugs.	

2.2.7 Bolts, Nuts and Washers

a. Bolts and nuts for pipe flanges, flanged fittings, valves and accessories must conform to ASME B18.2.1 and ASME B18.2.2, except as otherwise specified.

b. Bolts must be of sufficient length to obtain full bearing on the nuts and must project no more than three full threads and no less than two full threads beyond the nuts with the bolts tightened to the required torque.

c. Bolts must be regular hexagonal bolts conforming to ASME B18.2.1 with material conforming to ASTM A193/A193M, Class 2, Grade B8, stainless steel, when connections are made where a stainless steel flange is involved, and Grade B7, chromium molybdenum alloy, when only carbon steel flanges are involved. Bolts and nuts chosen must have sufficient strength to seat gasket types chosen. Bolts must be threaded in accordance with ASME B1.1, Class 2A fit, Coarse Thread Series, for sizes one-inch and smaller and Eight-Pitch Thread Series for sizes larger than one-inch.

d. Nuts must conform to ASME B18.2.2, hexagonal, heavy series with material conforming to ASTM A194/A194M, Grade 8, stainless steel for stainless steel bolts, and Grade 7, chromium molybdenum allow for chromium molybdenum alloy bolts. Nuts must be threaded in accordance with ASME B1.1, Class 2B fit, Coarse Thread Series for sizes one-inch and smaller and Eight-Pitch Thread Series for sizes larger than one-inch.

e. Provide washers under bolt heads and nuts. Use chromium molybdenum alloy washers dimensioned to ASTM F436 flat circular for chromium molybdenum bolts. Stainless steel washer dimensioned similar to ASTM F436 flat circular, use material the same as the bolt.

f. Use torque wrenches to tighten all flange bolts to the torque recommended by the gasket manufacturer. Tight in the pattern

recommended by the gasket manufacturer. Use anti-seize compound on stainless steel bolts.

2.2.8 Flange Gaskets, Non-Metallic, Non-Electrically Isolating

ASME B16.21, composition ring, using a Nitrile Rubber such as Buna-N and NBR, polytetrafluoroethylene (PTFE), or a fluoro rubber such as FKM, FPM and Viton©. The gasket must be 0.1250-inch thick. Gaskets must be resistant to the effects of aviation and non-aviation hydrocarbon fuels and manufactured of fire-resistant materials. Full-face gaskets must be used for flat-face flanged joints. Ring gaskets must be used for raised-face flanged joints. Gaskets must be of one piece factory cut. Select a gasket suitable for the working and test pressure of the fluid.

2.2.8.1 Nitrile Butadiene (Buna-N)

Provide Buna-N material that conforms to SAE AMS3275.

2.2.8.2 Acrylonitrile Butadiene Rubber (NBR)

Provide NBR material that conforms to SAE AMS3275.

2.2.8.3 Polytetrafluoroethylene (PTFE)

Provide PTFE material that conforms to ASTM F336.

2.2.8.4 Fluoro Rubber FKM

Provide FKM material that conforms to ASTM D1418.

2.2.8.5 Fluoroelastomer FPM

Provide FPM material that conforms to ISO 1629.

2.2.9 Flange Gaskets, Metallic

ASME B16.20, spiral-wound metal gaskets with inner and outer rings. Gaskets must be suitable for use on flat-face and raised-face flanges. The winding material is stainless steel 304 or 316L. The filler material is graphite or PTFE. The gasket must be in accordance with Military Specification MIL-G-24716. Select a gasket suitable for the working and test pressure of the fluid.

2.2.10 Flange Protectors

Protectors must protect the bolts, studs, nuts, and gaskets of a flanged end connection from corrosion or damage due to exposure to the environment. Protectors must be weather and ultraviolet (UV) resistant. Protectors must allow for quick and easy removal and re-installation by maintenance personnel. Provide grease filled bolt caps. Corrosion Prevention grease must be non-expansive and designed for the service. Provide protectors that allow visual inspection of the flange gasket without requiring removal. For electrically insulating flange connections, provide protectors with grease fittings that allow the injection of grease into the flange cavity.

2.2.11 Tank Overfill Prevention Valve (Pumped Fuel Receipt)

Valve must be the float-activated, shutoff type that is an integral part

of the drop tube used for pressurized fill systems. The valve must completely stop the flow of fuel into the tank, when the liquid level rises above 96.5 percent of tank capacity. Valve must be constructed of the same material as the fill tube. The overfill prevention valve must be testable with a cable.

2.3 MANUAL VALVES

All portions of a valve coming in contact with fuel in stainless steel pipelines or epoxy lined carbon steel pipelines must be of noncorrosive material. Valves in stainless steel pipelines or epoxy lined carbon steel pipelines must be Type 304 or Type 316 stainless steel or carbon steel internally plated with chromium or nickel or internally electroless nickel plated. Valves in unlined carbon steel pipelines must have carbon steel body. Stem and trim must be stainless steel for all valves. Manually operated valves 6 inches and larger must be worm-gear operated and valves smaller than 6 inches must be lever operated or handwheel operated. Valves smaller than 2 inches must have lever-type handles. Valves installed more than 8 feet above finished floor must have chain operators and a position indicators visible from ground level. Sprocket wheel for chain operator must be aluminum.

2.3.1 Ball Valves

Ball valves must be fire tested and qualified in accordance with the requirements of API Std 607 and API STD 608. Seal material for the fire test must be graphite, seal material for the project must be as as indicated below. Ball valves must be nonlubricated valves that operate from fully open to fully closed with 90-degree rotation of the ball. Valves 2 inches and larger must conform to applicable construction and dimension requirements of API Spec 6D, ANSI Class 150 and must have flanged ends. Valves 2 inches and larger must conform to applicable construction and dimension requirements of API Spec 6D, ANSI Class 150 and must have flanged ends. The balls in valves 10 inches and larger full port and 12 inches and larger regular port and larger must have trunnion type support bearings. Except as otherwise specified or indicated, reduced port or full port valves may be provided at the Contractor's option. Balls must be solid, not hollow cavity. Ball valves located in Isolation Valve Pits or vaults must be provided with handwheel extensions.

2.3.1.1 Materials

Ball must be stainless steel. Ball valves must have tetrafluoroethylene (TFE) or fluoroelastetomer (FKM), commonly referred to as Viton seats, body seals and stem seals. Valves 4 inches and smaller must have a locking mechanism.

2.3.1.2 V-Port Ball Valve

Valve must conform to requirements as specified for BALL VALVES paragraph in this section. Valve must be provided with characterized linear v-port for flow rate control, and with infinite position lever bracket with locking bolt for set position.

2.3.1.3 Electric Valve Actuator

Electric valve actuator must be as indicated for Plug (Double Block and Bleed) Valves, electric valve actuator.

2.3.2 Plug (Double Block and Bleed) Valves

API Spec 6D, API Spec 6FA, ANSI Class 150, non-lubricated, resilient, double seated, trunnion mounted, tapered lift plug capable of two-way shutoff. Valve must have tapered plug of steel or ductile iron with chrome or nickel plating and plug supported on upper and lower trunnions. Sealing slips must be steel or ductile iron, with Viton seals which are held in place by dovetail connections. Valve design must permit sealing slips to be replaced from the bottom with the valve mounted in the piping. Valves must operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves must have weatherproof operators with mechanical position indicators. Indicator shaft must be stainless steel. Minimum bore size must be not less than 65 percent of the internal cross sectional area of a pipe of the same nominal diameter unless bore height of plug equals the nominal pipe diameter and manufacturer can show equal or better flow characteristics of the reduced bore size design.

2.3.2.1 General

Valves in the operating tank suction and fill lines must be provided with a factory-installed limit switch that is actuated by the valve closure. Tank fill line valve and four valve manifold limit switches must be provided with one double pole double throw contacts or four single pole, double throw contracts, two for open, two for closed. Tank suction line valve limit switches must be provided with one double pole double throw contacts or four single pole, double throw contacts, for closed, and one single pole double throw contact or two single pole, double throw contacts for open. All components must be watertight and U.L. listed for Class I, Division 1, Group D hazardous areas.

2.3.2.2 Valve Operation

Rotation of the handwheel toward open must lift the plug without wiping the seals and retract the sealing slips so that during rotation of the plug clearance is maintained between the sealing slips and the valve body. Rotation of the handwheel toward closed must lower the plug after the sealing slips are aligned with the valve body and force the sealing slips against the valve body for positive closure. When valve is closed, the slips must form a secondary fire-safe metal-to-metal seat on both sides of the resilient seal. Plug valves located in Isolation Valve Pits or vaults must be provided with handwheel extensions.

2.3.2.3 Relief Valves

ANSI Class 150. Provide plug valves with automatic thermal relief valves to relieve the pressure build up in the internal body cavity when the plug valve is closed. Provide plug valves with automatic thermal relief valves to relieve the pressure build up around the valve when the plug valve is closed. Relief valves for around the valve are indicated on the drawings. Relief valves for the body cavitymust open at 25 psi differential pressure and must discharge to the throat of, and to the upstream side, of the plug valve.

2.3.2.4 Bleed Valves

ANSI Class 150, stainless steel body valve. Provide manually operated bleed valves that can be opened to verify that the plug valves are not leaking when in the closed position.

2.3.2.5 Electric Valve Actuator

The actuator, controls and accessories must be the responsibility of the valve-actuator supplier for sizing, assembly, certification, field-testing and any adjustments necessary to operate the valve as specified. The electric valve actuator must include as an integral unit the electric motor, actuator unit gearing, limit switch gearing, position limit switches, torque switches, drive bushing or stem nut, declutch lever, wiring terminals for power, remote control, indication connections and handwheel. The electrically actuated plug valve must be set to open and close completely in 30 to 60 seconds against a differential pressure of 275 psig. The actuator settings of torque and limit contacts must be adjustable. The valve actuator must be suitable for mounting in a vertical or horizontal position and be rated for 30 starts per hour. The valve actuator must be capable of functioning in an ambient environment temperature ranging from minus 22 to 158 degrees F.

a. The electrical enclosure must be specifically approved by UL or Factory Mutual for installation in Class I, Division 1, Group D locations.

b. The electric motor must be specifically designed for valve actuator service and must be totally enclosed, non-ventilated construction. The motor must be capable of complete operation at plus/minus 10 percent of specified voltage. Motor insulation must be a minimum NEMA Class F. The motor must be a removable subassembly to allow for motor or gear ratio changes as dictated by system operational requirements. The motor must be equipped with an embedded thermostat to protect against motor overload and also be equipped with space heaters. It must de-energize when encountering a jammed valve.

c. The reversing starter, control transformer and local controls must be integral with the valve actuator and suitably housed to prevent breathing or condensation buildup. The electromechanical starter must be suitable for 30 starts per hour. The windings must have short circuit and overload protection. A transformer, if needed, must be provided to supply all internal circuits with 24 VDC or 110 VAC may be used for remote controls.

d. The actuator gearing must be totally enclosed in an oil-filled or grease-filled gearcase. Standard gear oil or grease must be used to lubricate the gearcase.

e. The actuator must integrally contain local controls for Open, Close and Stop and a local/remote three position selector switch: Local Control Only, Off, and Remote Control plus Local Stop Only. A metallic handwheel must be provided for emergency operation. The handwheel drive must be mechanically independent of the motor drive. The remote control capability must be to open and close. Rim pull to operate valve manually must not exceed 80 pounds.

f. Position limit switches must be functional regardless of main power failure or manual operation. Four contacts must be provided with each selectable as normally open or normally closed. The contacts must be rated at 5A, 120 VAC, 30 VDC.

g. Each valve actuator must be connected to a PLC supplied by "others".

h. The actuator must have a local display of position even when power has been lost.

i. The actuator must be supplied with a start-up kit comprising installation instruction, electrical wiring diagram and spare cover screws and seals.

j. The actuator must be performance tested and a test certificate must be supplied at no extra charge. The test should simulate a typical valve load with current, voltage, and speed measured.

2.3.3 Swing Check Valves

Swing check valves must conform to API STD 600, regular type, ANSI Class 150 with flanged end connections. Discs and seating rings must be renewable without removing the valve from the line. The disc must be guided and controlled to contact the entire seating surface.

2.3.4 Silent Check Valves

Spring assisted, wafer/tapped lug pattern, butterfly check with or globe type FKM or PTFE seat ring, designed to prevent flow reversal slamming of valve, dual plate, and must conform to ASME B16.34, API Std 594, except face to face dimensions may deviate from standard. Valves must be suitable for installation in any orientation. Valve body and trim material must be as previously indicated herein.

2.4 THERMAL RELIEF VALVE

2.4.1 Valve Material

Valves must have stainless steel bodies and bonnets with stainless steel springs and trim. Valves must be Class 150 flanged end connections.

2.4.2 Thermal Relief Valve (Balanced Type)

Thermal relief valves that do not relieve to a zone of atmospheric pressure or atmospheric tank must be a balanced type relief or regulator valve.

Thermal relief valves must be the fully enclosed, spring loaded, angle pattern, single port, fully balanced type (back pressure must not affect relief pressure) back pressure regulator/relief valve. Set valve at pressure indicated on drawings. Valve body must have one-inch (minimum) raised face flange connections unless otherwise indicated. Orifice must have a minimum orifice size of 0.500-inch in diameter. Valve must have bubble-tight piston and seat design with stainless steel piston and Viton seat. Valve must be selected for the nominal flow condition of: pass a minimum of 5 gallons per minute, at a differential pressure of 55 psig, with a nominal set pressure of 50 psig. Valve must be factory configured to open at required set pressure but must be field adjustable by means of an enclosed adjusting screw.

2.5 PIPING ACCESSORIES

2.5.1 Mechanically Adjustable Segmented Elastomeric Seal

Mechanically adjustable segmented elastomeric seals must be constructed of fuel resistant Buna-N elastomers and Type 316 stainless steel fasteners

and hardware.

2.5.2 Pipe Sleeves

Pipe sleeves must be installed where indicated and at all points where the piping passes through concrete construction. Such sleeves must be of sufficient inside diameter to provide a minimum clear distance between the pipe and the sleeve of 1/2-inch. Sleeves through concrete pits or slabs must be standard weight carbon steel pipe with a protective coating. Each sleeve must extend through the respective pit wall or slab and must be provided with a wrap around Buna-N end seal (boot). (Viton when exposed to sunlight) and secured to the pipe sleeve and piping with adjustable stainless steel hose clamps. Sleeves where piping passes under roads or piping indicated to be double walled must be standard weight carbon steel pipe with a protective coating as previously specified. Alignment of the sleeve and piping must be such that the pipe is accurately centered within the sleeve by a nonconductive centering element. The sleeve must be securely anchored to prevent dislocation. Closure of space between the pipe and the pipe sleeve must be by means of a mechanically adjustable segmented elastomeric seal. The seal must be installed so as to be flush.

2.5.3 Strainers

2.5.3.1 Basket Type

Strainer must be single basket type arranged in a simplex configuration as indicated in compliance with MIL-PRF-13789, except as specified otherwise. Strainer end connections must be designed in accordance with ASME B16.5, Class 150. Strainer body material must be the same as the material specified for manual valves. Strainers must have removable baskets of 40 mesh wire screen with larger wire mesh reinforcement; wire must be stainless steel, Type 316. Pressure drop for clean strainer must not exceed 3 psig at maximum design flow rate. The ratio of net effective strainer area to the area of the connecting pipe must be not less than three to one. Each strainer must be provided with a suitable drain at the bottom, equipped with a ball valve. The strainer must be equipped with a direct-reading, piston type differential pressure gauge that measures the differential pressure across the basket as perin accordance with Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.5.4 Pressure Gauge

See Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

2.5.5 Pipe Supports

2.5.5.1 General

Pipe supports must conform to MSS SP-58. Design pipe supports to meet the applicable requirements of ANSI/ASME B31.3 or ANSI/ASME B31.4. Provide hot-dip galvanized finish on rods, nuts, bolts, washers, and supports. Provide miscellaneous metal that conforms to ASTM A36/A36M, standard mill finished structural steel shapes, hot-dipped galvanized. Provide galvanizing in accordance with ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, Z275 G90.

2.5.5.2 Adjustable Pipe Supports

Adjustable pipe supports must consist of a cast iron saddle and a threaded

nipple connected to a carbon steel pipe by means of a special reducer conforming to MSS SP-58. The supports must be provided with PTFE insulation strips.

2.5.5.3 Low Friction Supports

Supports must have self-lubricating anti-friction bearing elements composed of 100 percent virgin tetrafluoroethylene polymer and reinforcing aggregates, prebonded to appropriate backing steel members. The coefficient of static friction between bearing elements must be 0.06 from initial installation for both vertical and horizontal loads and deformation must not exceed 0.002-inch under allowable static loads. Bonds between material and steel must be heat cured, high temperature epoxy. Design pipe support elements for the loads applied. Provide anti-friction material with a minimum of 0.09-inch thick. Provide hot-dipped galvanized steel supports. Provide supports that are factory designed and manufactured.

2.5.5.4 U-bolt Half Round Supports

Supports must have anti-friction bearing half-round in contact with the bottom of the pipe. Provide Polytetrafluoroethylene or like hydrophobic, anti-corrosive material half-round with a compressive strength of at least 10 ksi or greater as required. U-bolts must be installed in either a loose or limited guide configuration as indicated on the design drawings. Provide hot-dip galvanized u-bolts with seamless non-metallic low friction coating. U-bolt connection must be double nutted on the bottom and single bolted on top.

2.5.5.5 Concrete and Grout

Concrete and grout for anchors and supports must comply with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.5.6 Sample Connections

a. Sample connections must be factory assembled units specifically designed for obtaining representative samples from fuel pipelines. Each connection must include a 1/4-inch sampling probe where the probe faces upstream, ball valve and 1/4-inch quick disconnect coupling with dust plug, all assembled into a unit that is suitable for installation in a pipe nipple. The sampling probe must extend not less than one-inch into the fuel pipe. All materials in the sample connections must be stainless steel or aluminum.

b. Furnish two sampling hose assemblies to the Contracting Officer at the project site. Each assembly must consist of a 6-foot length of 1/4-inch clear plastic tubing with internal bonding/grounding wire. One end of the tubing will contain a male connector that actuates flow when inserted into the quick disconnect coupler. Each end of the bonding/grounding wire must be equipped with clips for attaching to the pipe and metal sample container.

2.5.7 Pipe Insulation Systems

Provide mineral fiber insulation (ASTM C547-15) with a minimum of 1-inch thickness to aboveground fuel piping on outdoor filter-separator pad (Filter Shelter) in accordance with Section 23 07 00. Supply the insulation with manufacturer's recommended metal jacket. Provide similar

insulation and jacketing to associated valves and components on filter-separator pad. Install insulation external to heat-tracing system.

2.5.8 Sight Flow Indicators

Sight flow indicators must be ANSI Class 150 and must have flanged end connections. Sight flow indicators must consist of a housing containing a rotating propeller that is visible through a glass observation port. The housing must be stainless steel when installed in stainless steel lines and carbon steel when installed in carbon steel lines. The glass in the indicator must also meet the Class 150 rating.

2.5.9 Heat Trace

Heat trace must be electrical with materials selected for compatibility with transported liquids and ambient environment. The heat trace must be capable of maintaining the liquid process design temperature at 32 degrees F maximum when subjected to an exterior temperature of -10 degrees F. Ensure electrical work is in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, and UL listed, and includes all terminations, junction boxes, and automatic controls. Perform work in conformance to hazard classifications indicated on the drawings, and implement in accordance with NFPA 70, Section 427.

a. Provide UL listed parallel conduction type heat tape, with adjustable thermostat for outdoor aboveground winterized piping. Ensure tape is not affected by direct sunlight, ambient temperature, operating temperature, rain, or salt laden atmosphere. Provide flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cut-to-length at the job site and for wrapping around valves and complex fittings. Self-regulation must prevent overheating and burnouts even where the cable overlaps itself.

b. Provide end seals for ends of circuits. Wire at the ends of circuits are not to be tied together.

c. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at 34 degrees F minimum during winter outdoor design temperature as indicated, but not less than the following: 3 inch pipe and smaller with one inch thick insulation, 4 watts/feet; and 4 inch pipe and larger 1.5 inch thick insulation, 8 watts/feet of pipe.

2.6 FLEXIBLE HOSE CONNECTORS

Flexible hoses connectors for fueling pumps must have ANSI Class 300 or 150 flanges to mate directly to the pump and Class 150 flanges to the system flanges. Flanges must be stainless steel and must conform to ASME B16.5. These units must have an inner stainless steel or Inconel, corrugated tube with external stainless steel braid, and all components must be rated for not less than 275 psig at 100 degrees F. Face to Face dimension must be as recommended by the manufacturer. Use Inconel 625 inner bellows in coastal environments or where chlorides are present in the atmosphere.

For sizes larger than 6 inches, connectors must incorporate the use of Lo-corr, multi-ply bellows, without external braid, with bellows rating of 300 psig and overall rating consistent with the flange ANSI class. Flanges must be plate type, Vanstone design, with axial movement control

rods.

Fabricate piping to measurements established on the project site and position into place without springing or forcing. Make provisions for absorbing expansion and contraction without undue stress in any part of the system. The use of flexible connectors in permanently mounted pump suction and discharge lines as a method of compensating for piping misalignment is not acceptable.

2.7 AUTOMATIC AIR VENT

Unit must have one-inch connections and automatically vent air under pressure, and prevent a vacuum when pressure drops below a positive pressure. As fuel fills the vent, a float must rise and form a drip-tight closure. The unit pressure rating must be a minimum of 275 psi. The float must be stainless steel. Body and cover be carbon steel or ductile iron and be internally epoxy coated.

2.8 MISCELLANEOUS ACCESSORIES

2.8.1 Concrete Anchor Bolts

Concrete anchors must conform to ASTM A307, Grade C, hot-dipped galvanized.

2.8.2 Coatings for Bolts, Studs, Nuts, and Washers

Carbon steel bolts, studs, nuts, and washers must be provided with a factory applied hot-dipped zinc coating that conforms to ASTM F2329.

2.8.3 Polytetrafluoroethylene (PTFE) Tape

Tape must conform to ASTM D3308.

2.8.4 Escutcheon

Escutcheon must be the chrome plated, stamped steel, hinged, split ring type. Inside diameter must closely fit pipe outside diameter. Outside diameter must completely cover the corresponding floor, wall, or ceiling opening. Provided each escutcheon with necessary set screws.

2.8.5 Buried Utility Tape

Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape in minimum 3 inches width rolls, color coded for the utility involved, with warning identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning identification must be at least one-inch high and must state as a minimum "BURIED FUEL PIPING BELOW". Provide permanent code and letter coloring that is unaffected by moisture and other substances contained in trench backfill material.

2.8.6 Pipeline Markers

Provide pipeline markers constructed of 6 inches diameter, one-half inch thick bronze disk with a 3-inch long bronze headed bolt welded to the back of the disk. Engrave the front of the disk with the words "UNDERGROUND FUEL LINE" in the case of one line and "UNDERGROUND FUEL LINES" in the

case of multiple fuel lines.

2.9 FINISHES

2.9.1 Factory Coating

2.9.1.1 Valves

Valve surfaces must be blasted clean according to SSPC SP 5/NACE No. 1. Valve surfaces must be primed and coated in accordance with Section 09 97 13.27 HIGH PERFORMANCE COATING FOR STEEL STRUCTURES.

2.9.1.2 Equipment and Components

Unless otherwise specified, provide equipment and components fabricated from ferrous metal with the manufacturer's standard factory finish. For equipment and component surfaces subject to temperatures above 120 degrees F, the factory coating must be appropriately designed for the temperature service.

2.9.2 Field Painting

Painting required for surfaces not otherwise specified must be field painted as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aboveground stainless steel and aluminum surfaces. Do not coat equipment or components provided with a complete factory coating. Hot dip galvanized pipe support steel must not receive the Zinc-Rich Epoxy Primer Coat only the Epoxy Intermediate Coat and Polyurethane Topcoat must be applied to these surfaces. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

PART 3 EXECUTION

3.1 GENERAL

Installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with ASME B31.3 and NFPA 30, except as modified herein. Safety rules as specified in NFPA 30 and NFPA 407 must be strictly observed. Never direct bury threaded connections, socket welded connections, unions, flanges, valves, air vents, or drains. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible.

3.2 VERIFICATION OF DIMENSIONS

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.3 CLEANING OF PIPING

Keep the interior and ends of all new piping, affected by construction operations, thoroughly cleaned of foreign matter and water before and after being installed. Piping systems must be kept clean during installation by means of plugs or other approved methods. When work is not in progress, open ends of piping and fittings must be closed so that no water or other foreign substance will enter the pipes or fittings. Piping must be inspected before placing into position. The interior of each length of pipe must be cleaned after welding ensuring that the

interior of the piping is free of foreign matter when it is connected into the system.

3.4 TRENCHING AND BACKFILLING

Trenching and backfilling must conform to Section 31 00 00 EARTHWORK, and the following bedding and backfill requirements. The pipe must be laid in a bed of sand 6 inches deep, compacted in accordance with Section 31 00 00 EARTHWORK, paragraph BACKFILLING AND COMPACTION. Sand must meet the requirements of Section 31 00 00 EARTHWORK, paragraph SELECT GRANULAR MATERIAL. The full length of each section of pipe without any protective covering must be excavated to permit installation of the protective covering. Pipe that has the grade or joint disturbed after laying, must be taken up and relaid. Pipe must not be laid in water or when the trench or weather conditions are unsuitable for such work. After testing and application of protective covering to joints, sand backfill must be placed and compacted around the pipe or protective coating to a depth of one foot above top of pipe. The remainder of the backfill must be the same as for other types of pipe.

3.5 PIPING LAYOUT REQUIREMENTS

3.5.1 Pipe Fabrication

Fabricate piping to measurements established on the project site and position into place without springing or forcing. Make provisions for absorbing expansion and contraction without undue stress in any part of the system. The use of flexible connectors in permanently mounted pump suction and discharge lines as a method of compensating for piping misalignment is not acceptable.

3.5.2 Interferences and Measurements

Provide offsets, fittings, and accessories required to eliminate interferences and to match actual system components connection locations and arrangements. Verify measurements before commencing work. Submit discrepancies for clarification before proceeding with the installations to the Contracting Officer.

3.5.3 Space and Access

Keep piping, control tubing, which is not detailed close to structures and columns so as to take up a minimum amount of space. Ensure that access is provided for maintenance of system components, valves and gauges.

3.5.4 Location

Do not place unions in locations that will be inaccessible after the completion of the work. Place unions on each side of equipment.

3.5.5 Pipe Supports

Where provided hot dip galvanized pipe support steel must be surface prepped to SSPC SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals. Once the steel is prepped, apply only the Epoxy Intermediate Coat and Polyurethane Topcoat per manufacturer's instructions.

Provide pipe supports with the maximum spacing as defined in Table 1

below, unless otherwise indicated. At the indicated locations. Provide additional pipe supports at concentrated piping loads (valves).

Table 1. Maximum Support Spacing

Nominal Pipe Size (Inches)	one-inch and under	1.5-in	2-in	3-in	4-in	6-in	8-in	10-in	12-in
Maximum Support Spacing (ft)	7-ft	9-ft	10-ft	12-ft	14-ft	17-ft	19-ft	22-ft	23-ft

Provide anchors where required to absorb or transmit thrust or eliminate vibration or pulsation. Provide supports near each change of direction. Select support components which do not restrict the movement of the pipe due to thermal expansion. Space supports uniformly and arrange symmetrically.

3.5.6 Structural Support

Provide supplementary or intermediate steel or other structural members as required for transmission of loads to members forming part of the supporting structure. Piping must not be supported from other piping.

3.5.7 Grade

Where profiles of piping lines are shown on the drawings, grade the line uniformly between changes in slope or direction. Maintain gradient to within 1/4-inch over the entire length of pipe. When backfilling has been completed to the top of the pipe, the pipe must be surveyed at each joint, and logged by station number. Submit to the Contracting Officer for approval the survey final elevations before backfilling can continue.

3.5.8 Size Changes

Make changes in pipe size with reducing fittings. Do not use bushings. Make branch connections with butt-welded tees except where the branch is at least two pipe sizes smaller than the run, in which case the branch connection can be made with a forged or seamless branch outlet fitting. The branch outlet fitting must be designed in such a way that the connection can be radiographed. The branch outlet fittings may be a non-radiographicable if: the piping it is connected to is aboveground, the branch outlet size is 2.5 inches or less in diameter, and the branch outlet is located either in a pump house or on a system component pad equipped with containment curb.

3.5.9 Direction Changes

Make changes in direction of pipes with 1.5 D fittings. Make odd-angle offsets with pipe bends or elbows cut to the proper angle. Make changes in direction with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide sweep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of

bends must not be less than 6 diameters of the pipe if a pipe bender is used.

3.5.10 Threaded End Connections

Provide threaded end connections only on piping2 inches in nominal size or smaller and only where indicated on the drawings. Provide threaded connections with PTFE tape or equivalent thread-joint compound applied to the male threads only. Not more than three threads must show after the joint is tightened.

3.5.11 Existing Pipe Systems

No interruptions or isolation of an existing fuel handling service or system may be performed unless the actions are appropriately documented in the approved work plan. Perform initial cutting of existing fuel pipe with a multiwheel pipe cutter, using a nonflammable lubricant. After cut is made, seal interior of piping with a gas barrier plug. Refer to API RP 2009and API RP 2200. Purge interior of piping with carbon dioxide or nitrogen prior to performing any welding process.

3.5.12 Bolted Connections

For each bolted connection of stainless steel components (e.g., pipes, piping components, valves, and system components) use stainless steel bolts or studs, nuts, and washers. For each bolted connection of carbon steel components, use carbon steel bolts or studs, nuts, and washers. Bolts project no more than three full threads and no less than two full threads beyond the nuts with the bolts tightened to the required torque. Prior to installing nuts, apply a compatible anti-seize compound to the male threads.

3.5.13 Flanges and Unions

Except where threaded end connections or unions are indicated, provide flanged joints in each line immediately preceding the connection to system components or material requiring maintenance such as pumps, general valves, control valves, strainers, and other similar items and as indicated. Assemble flanged joints square and tight with matched flanges, gaskets, and bolts.

3.5.14 Flange Protector

Provide flange protectors where indicated on the drawings. Fill the flange cavity of electrically insulating flange connections with a corrosion inhibitor type grease. Provide grease filled bolt caps.

3.5.15 Manual Valves

Install isolation plug or ball valves on each side of each system equipment, at the midpoint of looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Install valves with stems vertically up unless otherwise indicated. Provide individual supports and anchors for each valve.

3.5.16 Air Vents

Provide 1-1/2 inches air vents at all high points and where indicated to ensure adequate venting of the piping system.

3.5.17 Drains

Provide 2 inches drains at all low points and where indicated to ensure complete drainage of the piping. Drains must be schedule 120.

3.5.18 Pipe Sleeves

Provide a pipe sleeve around any pipe that penetrates a wall, floor, or slab. Do not install sleeves in structural members except where indicated or approved. Install pipe sleeves in masonry structures at the time of the masonry construction. Sleeves must be of such size as to provide a minimum of 1/2-inch all-around clearance between bare pipe and the sleeve. Align sleeve and piping such that the pipe is accurately centered within the sleeve by a nonconductive centering element. Securely anchor the sleeve to prevent dislocation. Closure of the space between the pipe and the pipe sleeve must be by means of a mechanically adjustable segmented elastomeric seal. The seal must be installed so as to be flush. For wall or floor penetrations, extend each sleeve through its respective wall or floor and cut flush with each surface. Seal around sleeves that penetrate through valve or fuel related pits with a Buna-N casing seal. Seal around sleeves that penetrate through non-fire-rated walls and floors in accordance with Section 07 92 00 JOINT SEALANTS. Seal around sleeves that penetrate through fire-rated walls and floors as specified in Section 07 84 00 FIRESTOPPING.

3.5.19 Escutcheons

Except for utility or equipment rooms, provide finished surfaces where exposed piping pass through floors, walls, or ceilings with escutcheons. Secure escutcheon to pipe or pipe covering.

3.6 STRUCTURAL ATTACHMENTS

Provide attachment to building structure concrete and masonry by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Apply inserts and anchors with a safety factor not less than 5. Do not attach supports to metal decking. Construct masonry anchors for overhead applications of ferrous materials only. Structural steel brackets required to support piping, headers, and system components, but not shown, must be provided under this section. Material used for support must be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.7 WELDING

3.7.1 General

All joints, unless indicated otherwise, in carbon steel and stainless steel piping systems must be welded. Do not weld carbon steel to stainless steel. Welding of fuel pipe joints must comply with Section 33 52 23.15 POL SERVICE PIPING WELDING.

3.8 INSTALLATION

3.8.1 Precautions

Take special care to ensure that the protective coating on buried pipe is not damaged during installation and that the completed system is free of rocks, sand, dirt, water, weld slag, and foreign objects including

construction debris. Take the following steps to ensure these conditions.

a. Coated pipe must be handled only with canvas or nylon slings or padded clamps. Any coating damaged by improper handling or storage must be repaired as specified.

b. Pipe brought to the site must be stored on blocks or horses at least 18 inches above the ground and adequately supported to prevent sagging. Padded blocks or horses must be used for coated pipe. The method and height of storing coated pipe must be in accordance with the coating manufacturer's instructions. Pipe ends must be protected and capped against weather at all times, except to accommodate immediate installation.

c. Visual inspection must be made of the inside of each length of pipe to ensure that it is clear and clean prior to installation.

d. The open ends of the pipe system must be closed at the end of each day's work or when work is not in progress by use of expansion plugs and must not be opened until the work is resumed.

e. A swab, with a leather or canvas belt disc to fit the inside diameter of pipe, must be pulled through each length of pipe after welding in place.

f. Obstruction remaining in the pipe after completion of the system must be removed at the expense of the Contractor.

g. Plasma cutters and torches are not to be used to make penetrations in the pipe or to cut pipe.

3.9 INSTALLATION OF UNDERGROUND PIPE

Underground fuel pipelines must be pitched as shown on the drawings. Where not indicated they must be pitched a minimum of 2 inches per 100 feet. Two-inch pipe size valved drain connections must be provided at all low points and 1-1/2-inch pipe size valved outlet vent connections must be provided at all high points. Vent and drain lines must terminate in male cam-type locking end connectors with matching female dust covers and installed in pits. The pipe must have cover as shown on the drawings. Drain lines must be installed at the slopes indicated.

3.9.1 Pipe Assembly

Pipe must be strung parallel and adjacent to or above a trench. The pipe must be supported on padded skids during welding and inspection of joints. Protective coating must be inspected and repaired prior to lowering the pipe into the trench. The pipe must be lowered using only canvas or nylon slings. The sling must be dug from underneath the pipe after placements and must not be pulled from underneath the pipe while in contact with it. Care must be taken to prevent damage to the pipe, welded joints or coating and any such damage must be repaired as directed by the Contracting Officer. Pressure testing of the pipe must be done after it has been placed in final position in the trench.

3.9.2 Warning Tapes in Earth Trenches

For the purpose of early warning and identification of buried pipes outside of building walls during future trenching or other excavation,

continuous identification tapes must be provided in the trench. Provide metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured for the purpose of early warning and identification of utilities buried below the tape. Tape must be at least 3 inches in width. Color of tape must be as standard with the manufacturer with respect to the type of utility buried below the tape. Tape must have lettering at least one-inch high with warning and identification imprinted in bold black letters continuously over the entire tape length with not less than the following identification on the tape: BURIED JET FUEL PIPING BELOW. Tape must be installed in accordance with the printed recommendations of the tape manufacturer, as modified herein. Tapes must be buried at a depth of 6 inches from the top of the subgrade or 12 inches below the top surface of earth. Provide permanent color and printing, unaffected by moisture or soil.

3.9.3 Clearances

Install pipe to be clear of contact with other pipes, pipe sleeves, casings, reinforcing steel, conduits, cables, or other metallic structures. Where pipes cross other pipes or structures with a separation of less than 6 inches, install an insulating separator. Protect the pipe from contact with a 12-inch square by one-inch thick bituminous-impregnated canefiber board.

3.9.4 Protective Coating

When the protective coating on pipe is damaged, the Contracting Officer must be notified and must inspect the pipe before the coating is patched. If the damage to the pipe is deeper than 0.050-inch, the damage must be repaired by welding in accordance with paragraph WELDING. If the pipe is dented, out of round or damaged to the point that welding will not make it good as new, the length of pipe must be rejected.

3.9.5 Pipeline Markers

Provide above underground fuel piping spaced every 300 feet, at tees, and at changes in direction. For sections of underground piping less than 300 feet long, place at midpoint. Provide directly above pipe for single lines and between pipes where pipes run in pairs. Cast marker into 18-inch diameter, 12-inch thick concrete plug unless it is set in an area with concrete paving in which case it must be cast into the concrete paving.

3.10 SYSTEM COMMISSIONING

Conform to Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT).

3.11 TESTING

Piping must be tested by pneumatic and hydrostatic pressure. Testing must comply with applicable requirements of ASME B31.3, NFPA 30 and the requirements specified herein. Hydrostatic testing must be performed using fuelas the liquid. Pressure and hydrostatic testing must be performed only after welding inspection has been completed. Labor, materials, equipment, electricity, repairs, and retesting necessary for any of the tests required herein must be furnished by the Contractor. Provide provisions to prevent displacement of the piping during testing. Keep personnel clear of the piping during pneumatic testing. Only authorized personnel must be permitted in the area during pneumatic and

hydrostatic testing. Isolate system components such as pumps, tanks, filter separators, and meters from the piping system during the testing. Do not exceed the pressure rating of any component in the piping system during the testing. Following satisfactory completion of each test, relieve the test pressure and seal the pipe immediately. Piping to be installed underground must not receive field applied exterior coatings at the joints or be covered by backfill until the piping has passed the final pneumatic tests described herein.

3.11.1 Before Backfilling

Fuel piping must not be backfilled without completing the coating, pneumatic, weld radiograph and other piping examinations and approvals. Fuel piping in trench must not have exposed welds for longer than 30 days.

3.11.2 Pneumatic Test

Piping to be installed underground must not receive field applied protective covering at the joints or be covered by backfill until the piping has passed the pneumatic test described herein. To facilitate the tests, isolate various sections of the piping system and test each one separately. Where such sections terminate at flanged valve points, the line must be closed by means of blind flanges in lieu of relying on the valve. Furnish tapped flanges that can be attached to the end of the section of line being tested, and that will permit a direct connection between the piping and the air compressor or pressurizing pump. No taps in the permanent line will be permitted. Furnish all necessary equipment for testing; all gauges must be subject to testing and approval of the Contracting Officer. The air used for pneumatic testing must have a dew point of no more than 41 degrees F. Provide dehumidifying equipment on the suction or discharge side of the air compressor used to provide air for testing. Pressurizing pump must not exceed 10 cfm.

3.11.2.1 Pneumatic Test Procedure

Special safety measures, including the wearing of face mask, must be taken during testing under pressure. Only authorized personnel must be permitted in the area during testing. The pneumatic test pressure must be applied in increments. A preliminary 25 psig test must be applied. Maintain the pressure while soapsuds or equivalent materials are applied to the exterior of the piping. While applying the soapsuds, visually inspect the entire run of piping, including the bottom surfaces, for leaks (bubble formations). If leaks are discovered, repair the leaks accordingly and retest. Repeat process until system is leak-free at 25 psig. The full test pressure must then be applied. Unless otherwise directed by the Contracting Officer, all piping must be tested at a pressure of 100 psig for not less than 2-hours, during which time there must be no drop in pressure, only pressure rises with temperature. The pressure source must be disconnected during the final test period. Any leaks revealed by the test must be repaired and the test repeated.

3.11.3 Hydrostatic Test

Upon completion of pneumatic testing and after backfilling, hydrostatically test each underground piping system with water at 275 psig in accordance with ASME B31.3 and API RP 1110, with no leakage or reduction in gauge pressure for four hours. Upon completion of pneumatic testing, hydrostatically test each aboveground piping system with fuel at 275 psig in accordance with ASME B31.3 and API RP 1110, with no leakage or

reduction in gauge pressure for four hours. Furnish electricity, instruments, connecting devices, and personnel for test. Fuel must be furnished by the Government. If fuel is used for testing, comply with all the requirements in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). Defects in work must be corrected at the Contractor's expense, and the test repeated until the work is proven to be in compliance with the Contract requirements.

3.11.4 Performance Testing

After the fuel system testing is completed (including pneumatic and hydrostatic testing) the fuel system must be flushed, cleaned and performance tested as specified in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). All control valves, both manual and automatic, must be checked for leaks (any area wetted with fuel) and proper operation and adjusted, repaired or replaced to correct any defects.

3.12 DEMONSTRATIONS

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

3.13 POSTED OPERATING INSTRUCTIONS

As per requirements in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT).

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FUEL CONTROL VALVES
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.24	(2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

ASTM INTERNATIONAL (ASTM)

ASTM A194/A194M	(2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A216/A216M	(2012) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A269	(2010) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A320/A320M	(2011a) Standard Specification for Alloy/Steel and Stainless Steel Bolting Materials for Low-Temperature Service
ASTM A536	(1984; R 2019; E 2019) Standard Specification for Ductile Iron Castings
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM D2000	(2018) Standard Classification System for Rubber Products in Automotive Applications
ASTM D751	(2006; R 2011) Coated Fabrics

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS 3216	(2005; Rev G) Fluorocarbon (FKM) Rubber High-Temperature - Fluid Resistant Low Compression Set 70 To 80
SAE J200	(2011) Classification System for Rubber Materials
SAE J429	(2013) Mechanical and Material Requirements for Externally Threaded Fasteners

1.2 ADMINISTRATIVE REQUIREMENTS

Design conditions shall be as specified in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT). Components shall be suitable for ANSI Class 150 (275 psig at 100 degrees F).

a. Control valves specified herein shall be of one manufacturer. The valve manufacturer shall also produce the hydraulically-operated pilots. For each type control valve required and specified, submit the following:

(1). Flow diagrams.
(2). Operational description of the control valve and pilot control system.
(3). Complete valve assembly list of materials, along with material Certificates of Conformance, used in the manufacture of the control valves and pilot systems.
(4). sectional drawings of main valve and control pilot systems.

b. Before shipment, each individual control valve shall be operationally tested and adjusted by manufacturer under actual flow conditions utilizing a hydrocarbon test fluid with a specific gravity comparable to DS1/2 fuel. Manufacturer shall submit certified records of test data.

c. Operation and maintenance information shall be submitted for each individual type control valve specified herein. Refer to Section 01 78 23.33 OPERATION AND MAINTENANCE MANUALS FOR FUEL SYSTEMS for the information to be submitted.

1.3 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following

in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Control Valves; G, DO

SD-03 Product Data

Control Valves; G, DO

SD-06 Test Reports

Control Valves

SD-07 Certificates

Previous Air Force/Military Projects; G, RO
Qualified Engineers; G, RO
Field Assistance; G, RO

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, RO

1.4 QUALITY ASSURANCE

1.4.1 Field Assistance

Provide the following:

a. Proof of experience on previous Air Force/Military projects

b. Number of qualified engineers (factory trained)available to provide startup support.

c. Written assurance as to ability to respond to specified time for field assistance.

1.4.2 Training

The manufacturer shall conduct two eight hour training classes for Liquid Fuels Maintenance Technicians which include valve overhaul procedures, pilot overhaul procedures, valve adjustments, and valve diagnostics. The manufacturer shall provide a 4-inch valve mock-up with various trim components (i.e., rate of flow, solenoid control, and speed control features) to be used during training. Video taping of training shall be allowed or provided at the time of the class, and an attendance roster maintained by the Contractor. The 4-inch valve mock-up shall become the property of the Government and shall be turned over to the Contracting Officer. Submit copies of the Operation and Maintenance Manuals for approval.

1.5 WARRANTY

If a problem attributable to the valve's manufacturer or installation arises after the initial system start-up has been accomplished, and after system final acceptance date, 48 hours from the time of notification that a problem exists is allowed to solve the problem. The problem shall be solved to the satisfaction of the Contracting Officer. If the Contractor

cannot effectuate a proper resolution to the problem as outlined above in the 48 hour period, provide a factory trained engineer from the manufacturer of the valve within 48 hours after the expiration of the Contractor's initial 48 hour period to effectuate a resolution of the problem above. All services provided by the valve manufacturer shall be at no cost to the Government. When it has been determined by the Contractor, Contracting Officer, and the valve manufacturer's representative that the valve(s) cannot be repaired in its installed position in the fuel system, it shall be replaced with a new valve and pilot assembly within 48 hours after the initial 96-hour period listed above expires and at no cost to the Government.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

The type of materials which come in contact with the fuel, if not specified herein before, shall be noncorrosive.

2.2 CONTROL VALVES

2.2.1 General

Control valves shall be single-seated globe type, diaphragm actuated, hydraulically operated valves. Valves shall consist of 3 major components: the valve body, valve cover, and diaphragm assembly. The diaphragm assembly shall be the only moving part. In the event of diaphragm failure, valve shall fail closed against flow, unless otherwise indicated. The main valve shall be drip-tight when closed. Each valve shall have an external indicator to show the position of the valve disc at all times. Control valves shall be shipped from the factory as a complete assembly with all pilot controls and pilot auxiliary piping properly installed on the main valve. Materials which come in contact with the fuel shall be resistant to the effects of and not harmful to aircraft engine fuel and shall be stainless steel, or electroless nickel plated ductile iron unless noted otherwise. Materials for control valves, and items to be mounted on the valves shall be as follows:

2.2.1.1 Bodies, Bonnets, and Covers

Shall be constructed of one of the following materials:

a. Cast steel conforming to ASTM A216/A216M, Grade WCB internally plated with chromium, nickel or internally electroless nickel plated.

b. Cast stainless steel conforming to ASTM A743/A743M.

c. Ductile iron conforming to ASTM A536, electroless nickel plated.

d. Bodies shall have flanged inlet and outlet connections. Valve shall have a screwed bottom drain plug.

2.2.1.2 Valve Seats

Valve seats shall be stainless steel in accordance with ASTM A743/A743M. It shall be possible to remove the valve seat while the valve is connected in the line. Valve seat and upper stem bearing shall be removable and screwed in the body and/or cover. The lower stem bearing must be concentrically contained in the valve seat and shall be exposed to flow on

all sides. The diameter of the valve seat shall be the same size as the inlet and/or outlet flanges of the main valve.

2.2.1.3 Valve Discs

Valve discs shall contain a resilient, fluoroelastomer (FKM), commonly referred to as Viton disc conforming to SAE AMS 3216 having a rectangular cross section, contained on 3.5 sides by a disc retainer and a disc guide, forming a drip tight seal against the seat. The disc shall be usable on either side. The disc guide shall be the contoured type capable of holding disc firmly in place during high differential pressure conditions that may develop across the seating surface. The disc retainer shall be capable of withstanding rapid closing shocks.

2.2.1.4 Diaphragm Assembly

Diaphragm Assembly shall form a sealed chamber in the upper portion of the valve, separating the operating fluid from the line pressure. The diaphragm assembly shall contain a valve stem which is fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. Valve body and cover shall be sealed by the diaphragm. Valve stem shall be stainless steel. The bearing material shall be compatible with the fuel specified and shall not contain zinc coated metals, brass, bronze, or other copper bearing alloys. The diaphragm shall be of a nonwicking material or design, with a minimum of 2 layers of nylon fabric bonded with a minimum of 3 layers of synthetic rubber (valves 2-1/2 inches and smaller one layer of nylon fabric). The edge area of the center hole for the valve stem shall be sealed by vulcanization. Materials to be resistant to aromatics of up to 50 percent in accordance with ASTM D2000 (SAE J200). The diaphragm must have a MULLINS-burst rating according to ASTM D751 of a minimum of 600 psi per layer of nylon fabric. All diaphragm sizes must be cycle tested to a minimum of 100,000 cycles, by alternately applying pressure under the diaphragm (main valve pressure) and above the diaphragm (cover chamber pressure). That test shall be certified by the manufacturer. The diaphragm shall not be used as a seating surface. The diaphragm must be fully supported by the body and cover in either the open or closed position.

2.2.1.5 Bolts, Screws and Nuts

a. For Ductile Iron, and Cast Steel Body Valves.

(1) Bolts and Screws, cadmium plated steel in accordance with SAE J429, Grade 5.

(2) Nuts, cadmium plated steel in accordance with ASTM A194/A194M, Grade 2 H.

b. For Stainless Steel Body Valves. Bolts, Screws and Nuts, ASTM A320/A320M, Grade B8M C.1.1.

2.2.1.6 Pilot Control System and Auxiliary Piping

Pilot Control System and auxiliary piping shall be stainless steel, seamless, fully annealed tubing conforming to ASTM A269, Grade TP316, Rockwell hardness B80 or less. Wall thickness for 1/2-inch tubing to be 0.049-inch. Threaded connections shall be used in pilot system piping and shall be o-ring type with FKM o-rings. Tubing connections shall not be welded.

2.2.1.7 Pilot Valves

Pilot valves shall have stainless steel bodies conforming to ASTM A743/A743M with stainless steel internal working parts. Disc and diaphragm assemblies shall be as specified herein before. The setting of adjustable type pressure operated pilot valves shall be easily adjusted by means of a single adjusting screw. The adjusting screw shall be protected by a threaded cap drilled to accommodate a lead-seal wire and a lock nut shall be provided on the adjusting screw to lock it in position at the desired setting. The lead seal wire shall be installed after final acceptance of the system. Spare wire seals and the "embossing" tool will be turned over to the Contracting Officer for the LFM shop.

2.2.1.8 Solenoids

Solenoids for operation of pilot valves shall be housed in an explosion-proof case suitable for Class I, Division 1, Group D with maximum temperature rating of T2D (419 degrees F), hazardous locations as defined in NFPA 70. Solenoids shall operate on 120 volts, 60 cycle, single phase, alternating current. A manual type operator or needle valve to bypass the solenoid valve shall be provided for emergency manual operation.

2.2.2 Serviceability of Main Valve Internal Parts

Main valve movable parts including strainers, valve seat, stem bearings, and control system shall be replaceable without removing the main valve from the line. All nonmetallic parts shall be replaceable.

2.2.3 Total Lengths

The total valve length does not include the orifice plate flange (when used). If the control valve being supplied has the orifice plate built into its flange, the spacer provided shall bring the valve face-to-face dimension equal to those listed below plus 0.0875 inch. The lengths of the valves shall be equal for the following materials: cast stainless steel, cast steel, and ductile iron.

SIZE inches	VALVE LENGTH inches
1-1/2	8.5
2	9.375
3	12
4	15
6	20
8	25.4
10	29.8
12	34

SIZE inches	VALVE LENGTH inches
14	39
16	41.375
Note: Tolerance shall be ±0.03 inch for size 1-1/2 inches through 8 inches and ±0.06 inch for size 10 thru 16 inches.	

Control valves not meeting these face to face dimensions shall be supplied with spacers suitable for the proper installation of the valve.

2.2.4 Flanges

MATERIAL	SEALING SURFACE
Cast Steel, ASME B16.5 Class 150	Raised Face
Cast Stainless Steel, ASME B16.5	Raised Face Class 150
Ductile Iron, ASME B16.24 Class 150	Flat Face
Note: The mating flange shall be made the same as above.	

2.2.5 Identification

2.2.5.1 Main Valve Body

The following shall be cast into the main valve body:

a. Pressure Class
b. Size
c. Material
d. Foundry Heat Number and Identification
e. Manufacturer
f. Flow Pattern

2.2.5.2 Main Valve Cover

The following shall be cast into the main valve cover:

a. Size
b. Material
c. Foundry Heat Number and Identification

2.2.5.3 Brass Name Plates

Brass name plates shall be fastened to the valve. Body name plates shall list the following:

a. Size
b. Model Number
c. Stock Number
d. Manufacturer/Supplier

e. Manufacturer's Inspection Stamp

2.2.5.4 Inlet Name Plate

Inlet name plate shall list the following:

a. Size
b. "Inlet" Marking
c. Assembly Model Number
d. Part Number

2.2.5.5 Outlet Name Plate

Outlet name plate shall list the "Outlet" Marking.

2.2.5.6 Pilot Valves

Pilot valves shall be tag identified. The valve shall have the field adjusted start up setting engraved on a plastic tag, white with black lettering.

2.3 INDIVIDUAL CONTROL VALVE OPERATIONAL REQUIREMENTS

Operation, performance, and special features of the individual control valves shall be as specified herein.

2.3.1 Non-Surge Check/Air Block Valve (AB/CV-1)

2.3.1.1 Size

4 inch

2.3.1.2 Flow

0-340 GPM.

2.3.1.3 Operation

Backpressure control pilots will cause main valve to modulate to maintain constant inlet pressure. There shall be 3 backpressure control pilots, A, B, and C. Pilot A shall be solenoid enabled and set at pressure which corresponds with unloading pump flow rate of 300 GPM. Pilot B shall be solenoid enable and set at pressure which corresponds with unloading pump flow rate of 150 GPM. Pilot C shall be a 2 inch solenoid controlled control valve set at pressure corresponding with unloading pump flow rate of 75 GPM. All pilots are to have 20-200 PSIG range.

2.3.1.4 Speed Control

Valve shall open slowly. Opening speed shall be adjustable from two (2) to 30 seconds without affecting closing of valve. Factory set for 15 seconds. The valves shall fail closed against reverse flow in check condition.

2.3.1.5 Check Feature

Valve closure to be rapid, closing quickly when outlet pressure exceeds inlet pressure.

2.3.1.6 Solenoid Control

Solenoid control of valve shall be as indicated on the drawings.

2.3.1.7 Strainer

A 40-mesh, stainless steel wire, self-cleaning strainer shall be provided in the pilot valve supply piping.

2.3.2 Filter Separator Control Valve (FSCV-1 and FSCV-2)

2.3.2.1 Size

2-inch

2.3.2.2 Flow

100 GPM

2.3.2.3 Operation

Filter Separator Control Valve shall limit flow to 100 GPM. Controlling to be by orifice. Rate of flow to be manually adjustable and utilize a downstream orifice plate holder.

2.3.2.4 Check Valve Feature

Valve shall close rapidly when outlet pressure exceeds inlet pressure.

PART 3 EXECUTION

3.1 VALVE TESTING AND START-UP SUPPORT

Provide the services of a factory trained and certified service engineer authorized/sanctioned/certified by the valve manufacturer to verify that each valve has been properly installed and to verify valves were factory operationally tested, adjusted and set per these specifications. The service engineer shall assist the Contractor in the valve start-up adjustment process and will remain on site until all control valves function as required by the contract documents.

-- End of Section --

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SECTION 33 52 43.28

FILTER SEPARATOR, FUELING SYSTEM
08/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.3	(2022; Errata 2023) Process Piping
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM C827/C827M	(2023) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-P-5315	(2022, Rev B) Butadiene - Acrylonitrile (NBR) Rubber For Fuel-Resistant Seals 60 To 70

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-PRF-4556	(1998; Rev F; Am 1 1999; CANC Notice 1 2011) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
MIL-STD-130	(2007; Rev N; Change 1 2012) Identification Marking of U.S. Military Property

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1923	(Rev A; Notice 1; Notice 2; Notice 3; Notice 4) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)

1.2 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Filter Separator; G, DO

SD-03 Product Data

Filter Separator; G, DO

Heating Element; G, DO

SD-07 Certificates

Filter Separator

SD-10 Operation and Maintenance Data

Filter Separator; G, RO

1.3 DESIGN CONDITIONS

Design conditions must be as specified in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON-HYDRANT)and as modified herein.

1.4 WORKMANSHIP

Each filter separator, including all parts and accessories, must be free from blemishes, defects, burrs and sharp edges. The vessel must exhibit accuracy of dimensions, accurate radii of fillets and complete marking of parts and assemblies.

1.5 CLEANING

Components of the filter separators must be cleaned to remove dirt; excess soldering; brazing, and welding flux; welding slag; loose, spattered, or excess solder; metal chips; and other foreign materials before, during and after assembly.

PART 2 PRODUCTS

2.1 WELDING

Welding must be in accordance with ASME B31.3.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Housing

a. Carbon steel with internal epoxy coating.

b. Float Assembly. Stainless steel.

c. Manual Drain Valve. Stainless steel.

d. Sight Glass. Armored clear Pyrex with nickel-copper alloy ball checks.

e. Differential Gauge. Corrosion resistant piston with stainless steel valves.

f. Separators. 200 mesh stainless steel wire cloth, polytetrafluorethylene (PTFE) coated on both sides, or synthetic mesh cloth.

2.3 FILTER SEPARATOR CONSTRUCTION

2.3.1 Housing Vessel

Each filter separator housing must be fabricated from carbon steel and must be internally coated with an epoxy coating in accordance with MIL-PRF-4556 . Each unit must be constructed and labeled in accordance with ASME BPVC SEC VIII D1. The housing must be designed for a working pressure of 150 psig. Each unit must be vertical, top-opening type with coalescers and separators mounted side-by-side (coalescers at the inlet of the vessel and separators at the outlet). The head opening must be equipped with a hinged or pivoting device to facilitate swinging the head to one side for servicing. The hinges or pivots must support the head during servicing without distortion or misalignment. Swing-type bolts must be used on all main closures. Unit must be provided with 3-inch inside diameter lifting eyes spaced to support a weight of 2-1/2 times the gross weight of the filter separator. The configuration of the pressure vessel must be as shown on the drawings. The housing must be provided with a 3/4-inch inlet compartment fuel drain plug. A hand hole access plate must be provided in the inlet compartment. The head must be sealed to the body by means of an O-ring, meeting requirements of SAE AMS-P-5315, mounted in a circular groove at the point of closure. Threaded base mounting adapters must be provided for the coalescers. The separators must be mounted on adapters with blunted Vee-type knife edges. Height of Vee section to be 0.06 inches, plus or minus 10 percent. Weld ridges must not prevent liquid from draining. The filter separator vessel must be able to withstand a force of 2400 pounds and a moment of 2400 foot-pounds at the flanges.

2.3.2 Legs

Two 2 x 12 x 1/2 inch legs must be welded to the housing. These legs will serve as the base plates and will be secured to the filter separator equipment pad. Each leg must have two drilled through 5/8-inch holes.

2.3.3 Inlet and Outlet Connections

The inlet and outlet connections must be 2 inch nominal pipe size. Inlet and outletconnections must be provided with raised face flanges, faced and

drilled in compliance with ASME B16.5, Class 150..

2.3.4 Manual Drain Valve

As specified in paragraph ACCESSORIES.

2.3.5 Sight Gauge

As specified in paragraph ACCESSORIES.

2.3.6 Differential Pressure Gauge

As specified in paragraph ACCESSORIES.

2.3.7 Automatic Air Eliminator and Pressure Relief Valves

As specified in paragraph ACCESSORIES.

2.3.8 Sampling Connections

As specified in paragraph ACCESSORIES.

2.3.9 Spider Assembly

Each filter separator must contain a spider assembly to hold the coalescers and separators in position, to support them firmly against vibration. The method of stabilization must assure an electrical bond between the spider and the vessel.

2.3.10 Coalescer and Separator Cartridges

Each filter separator must be provided with coalescers and separators that have been qualified to the performance requirements of ISO 4406 14/13/11. The design flow-rate is 100 gpm .

2.3.11 Control Valve Accessories

Provide each filter separator with a control valve (FSCV), and manual water drain valve as specified in Section33 52 43.14 FUEL CONTROL VALVES and must be of the same manufacturer.

2.3.12 Identification of Product

Equipment, assemblies, and parts must be marked for identification in accordance with MIL-STD-130. The main equipment nameplate must be mounted on the housing, and in addition to the usual MIL-STD-130 requirements, must include the following markings in letters 3/32 inch high or larger:

Filter Separator, Liquid Fuel	
Design Flow-Rate	
Design Pressure	
Elements	

First Stage		Mfg. Part No. *	
Second Stage		Mfg. Part No. *	
Contract No. *			
Manufacturer *			
Specification*			
*Applicable information must be entered by the Contractor.			
*Applicable information must be stenciled by LFM personnel.			

2.3.13 Assembly

Each filter separator must come assembled with all accessories and must be ready for use. The functions of all components must be tested prior to shipment and no assembly or field adjustment of valves or components must be required.

2.4 ACCESSORIES

2.4.1 Manual Drain Valve

Each filter separator must be equipped with a 1-inch stainless steel manual ball valve water and fuel drain. The valve must be capable of draining all water, fuel and sediment from the filter separator by gravity. The valve must be installed below the sump of the housing as shown on the drawings.

2.4.2 Sight Gauge

A 1/2-inch armored, clear borosilicate (Pyrex) liquid level gauge must be provided for observing the water accumulation in the sump. The gauge must be equipped with stainless steel ball checks in both the upper and lower fittings, an upper and lower shutoff valve, and a bottom blowoff cock. Liquid level gauges must be rated for a maximum pressure of 150 psi.

2.4.3 Differential Pressure Gauge

The housing must be equipped with a direct-reading, piston type differential pressure gauge that measures the differential pressure across both coalescers and separators. The gauge must consist of a spring-supported, corrosion resistant piston moving inside a glass cylinder, with high pressure applied on top of the piston and low pressure applied below it. The gauge must have a peak-hold reading that locks the piston to indicate the maximum differential pressure that is measured until the piston is released by turning a knob, a push button test valve to relieve pressure under the piston, and a pressure relief feature set at 300 psi to protect the gauge if isolation valves have been left closed. Under a differential pressure of 30 psi, leakage past the piston must not exceed 120 drops per minute. The cylinder and flanges must be stainless steel with fluoroelastomer (FCM), commonly referred to as Viton, O-ring seals. The high pressure inlet of the gauge must have a 10-micron pleated

paper filter and the low pressure connection must have a fine mesh stainless steel strainer. The gauge must have an operating pressure of 300 psi. Differential pressure range of the gauge through approximately 3 inches of piston movement must be 0-30 psi with an accuracy of + 0.5 psi, calibrated linearly with 1 PSI scale graduations. High and low pressure connections must be 1/4 inch NPT female with a stainless steel bar stock valve at each connection. Construction of the gauge must be such that a 3-valve manifold is not necessary. If only one bar stock valve is closed, the gauge must not be damaged by up to 300 psi differential pressure in either direction. The differential pressure gauge must be attached to the filter separator by a gauge panel. A pressure gauge must be attached to the differential pressure gauge to indicate the high pressure and have a range of 300 psi.

2.4.4 Automatic Air Eliminator and Pressure Relief Valves

A 1-inch angle pattern pressure relief valve must be provided on top of each vessel. An automatic air eliminator must be installed on the highest point of the vessel and must have check valve feature. The air eliminator must release at pressures up to 150 psi with no fuel leakage allowed.

2.4.5 Sampling Connections

Sampling connections must be provided at the inlet and outlet connections to the housing. Each sampling connection must consist of a 1/4-inch sampling probe where the probe faces upstream, ball valve, a quick disconnect coupling and aluminum dust cap. The sampling connections must be capable of accepting a sampling kit for drawing the samples required to assure fuel quality.

2.4.6 Heating Element

Each filter separator must be equipped with sump heating element to prevent formation of ice in water drain system and prevent diesel from gelling. Heater must be have working pressure of at least 150 psi and be rated for use in diesel. Heater must be thermostatically controlled.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and components in position, true to line, level and plumb and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for equipment installation. Provide required clearance between equipment components. Equipment apparatus, and accessories requiring normal servicing or maintenance to be accessible.

3.1.1 Anchoring

Anchor equipment in place. Check alignment of anchor bolts before installing equipment and cleanout associated sleeves. Do not cut bolts because of misalignment. Notify Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads. Where anchor bolts or like devices have not been installed, provide appropriate self-drilling type anchors for construction condition. Expansion bolt anchors provided must be in accordance with CID A-A-1923, Type 4, Class One, 1/2 inch size.

3.1.2 Grouting

Equipment, which is anchored to a pad, must be grouted in place where applicable. Before setting equipment in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, coatings and other materials which impair bond. Clean contaminated concrete by grinding or other acceptable means. Provide necessary formwork for placing and retaining grout. Grout to be nonmetallic, nonshrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum power agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, premixed and packaged at factory with only the addition of water required at the project site. Grouting to meeting requirements of ASTM C827/C827M. Perform grouting in accord with ACI, equipment manufacturer's, and grout manufacturer's published specifications and recommendations.

3.1.3 Leveling and Aligning

Level and align equipment in accordance with respective manufacturer's published data. Do not use anchor bolts, jack-nuts or wedges to support, level or align equipment. Install only flat shims for leveling equipment. Place shims to fully support equipment. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than equipment bearing surface. Shims to provide for full equipment support. Shims to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.1.4 Painting

Equipment painting must be as specified in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT). Equipment labeling must be as specified in Section 33 57 55 FUEL SYSTEM COMPONENTS (NON_HYDRANT).

-- End of Section --

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SECTION 33 56 10

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05/19, CHG 1: 11/20

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SECTION 33 56 10

FACTORY-FABRICATED FUEL STORAGE TANKS
05/19, CHG 1: 11/20

PART 1 GENERAL

1.1 SUMMARY

This section defines the requirements for factory-fabricated fuel storage tanks.

1.1.1 Related Sections

1.1.1.1 Earthwork

Excavation and backfilling for tanks must be as specified in Section 31 00 00 EARTHWORK.

1.1.1.2 Leak Detection

Leak detection must be as specified in Section 33 01 50.31 LEAK DETECTION FOR FUELING SYSTEMS.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN PETROLEUM INSTITUTE (API)

API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 1615	(2011) Installation of Underground Petroleum Storage Systems
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2020) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and

	Other Special Purpose Applications
ASTM A194/A194M	(2023) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM D3308	(2012; R 2017) Standard Specification for PTFE Resin Skived Tape
ASTM F436	(2011) Hardened Steel Washers
ASTM F844	(2019) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)	
IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 30	(2024) Flammable and Combustible Liquids Code
NFPA 30A	(2024; ERTA 1 2023) Code for Motor Fuel Dispensing Facilities and Repair Garages
NFPA 31	(2020; TIA 23-1) Standard for the Installation of Oil-Burning Equipment
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 77	(2024) Recommended Practice on Static Electricity
NFPA 407	(2022; TIA 21-1) Standard for Aircraft Fuel Servicing
NFPA 704	(2022) Standard System for the Identification of the Hazards of Materials

	for Emergency Response
NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC QP 3	(2010) Standard Procedure for Evaluating Qualifications of Shop Painting Applicators
SSPC QS 1	(2015) Standard Procedure for Evaluating a Contractor's Advanced Quality Management System

STEEL TANK INSTITUTE (STI)

STI 020-50-1000	(2010) ACT-100 Specification for External Corrosion Protection of FRP Composite Steel USTs
STI 700-50-5007	(2010) Installation Instructions for Shop Fabricated Aboveground Tanks for Flammable, Combustible Liquids
STI SP001	(2018, 6th Ed) SP001 Standard for The Inspection of Aboveground Storage Tanks

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-161	(2015; Rev H) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels
UFC 3-301-02	(2023) Design of Risk Category V Structures, National Strategic Military Assets

UL SOLUTIONS (UL)

UL 142	(2006; Reprint Jan 2021) UL Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 1316	(2018; Reprint Mar 2019) UL Standard for Safety Fiber Reinforced Underground Tanks for Flammable and Combustible Liquids
UL 1746	(2007; Reprint Dec 2014) External Corrosion Protection Systems for Steel Underground Storage Tanks

1.3 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S"

classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding

Aboveground Lube Oil Storage Tank (Double Wall Steel); G, DO

SD-03 Product Data

Aboveground Storage Tank (Single Wall Steel); G, DO

Aboveground Lube Oil Storage Tank (Double Wall Steel); G, DO

Underground Storage Tank; G, DO

Tank Protective Coatings; G, DO

Atmospheric Vent; G, DO

Emergency Vent; G, DO

Tank Gauges; G, DO

Manhole Containment Sump; G, DO

SD-06 Test Reports

Aboveground Storage Tank Tightness Tests; G, RO

Underground Storage Tank Tightness Tests; G, RO

Tank Manufacturer's Tests; G, RO

Tank Fill Tests; G, RO

Tank Inspection Reports; G, RO

SD-07 Certificates

Contractor Qualifications; G, RO

Manufacturer's Certification; G, RO

State Certification; G, RO

Pollution Liability Insurance; G, RO

Permitting; G, RO

Registration; G, RO

Licensed Personnel; G, RO

Demonstrations; G, RO

STI SP001 Inspector's Certification; G, RO

SD-08 Manufacturer's Instructions

Underground Storage Tank; G, RO

Tank Gauges; G, RO

SD-10 Operation and Maintenance Data; G, RO

Aboveground Storage Tank; G, RO

Underground Storage Tank; G, RO

Tank Gauges; G, RO

1.3.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.4 QUALITY ASSURANCE

1.4.1 Contractor Qualifications

Each installation Contractor must have successfully completed at least 5 projects of the same scope, and the same size or larger within the last 3 years and demonstrated specific installation experience in regard to the specific system installation to be performed. Each installation Contractor must have taken, if applicable, manufacturer's training courses on the installation of storage tanks and must meet all applicable licensing requirements in the state. If applicable, state certified installers must be provided by the Contractor. Installers must also be trained and certified by the manufacturer to install the equipment and materials being installed and must be STI certified. Installers must submit certification from the manufacturer and State. If installing underground storage tanks and piping systems, installation Contractor must have Pollution Liability Insurance. Submit a letter listing prior projects, the date of construction, a point of contact for each prior project, the scope of work of each prior project, and a detailed list of work performed. The letter must also provide evidence of prior manufacturer's training, state licensing, and other related information.

1.4.2 Regulatory Requirements

1.4.2.1 Permitting

Obtain necessary permits in conjunction with the installation of storage tanks as required by federal, state, or local authority. This requirement shall also pertain to the Oil Water Separator in Section 46 25 14 COALESCING OIL-WATER SEPARATORS.

1.4.2.2 Registration

Obtain and complete all tank registration forms required by federal, state, and local authorities. Submit all completed tank registration forms within 30 days after contract award to the Contracting Officer. The Contracting Officer will ensure the Base Environmental staff for the DoD

Installation submits the forms to the proper regulatory agencies. This requirement shall also pertain to the Oil Water Separator in Section 46 25 14 COALESCING OIL-WATER SEPARATORS.

1.4.2.3 Licensed Personnel

Tank installers must be licensed/certified by the state when the state requires licensed installers. This requirement shall also pertain to the Oil Water Separator in Section 46 25 14 COALESCING OIL-WATER SEPARATORS.

1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer, upon recommendation by Base Environmental for the DoD Installation. Replace damaged or defective items.

1.6 PROJECT/SITE CONDITIONS

Exposed moving parts, parts that produce high operating temperatures and pressures, parts that may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Install safety devices so that proper operation of equipment is not impaired.

1.7 WARRANTY

All factory-fabricated storage tanks must come with a manufacturer's warranty of a minimum period of 30 years. All warranty paperwork will be completed and submitted by Contractor to both the tank and system component manufacturers, the Contracting Officer, and the Base Environmental for the DoD Installation. This includes all applicable completed manufacturers' equipment installation checklists.

PART 2 PRODUCTS

2.1 ELECTRICAL WORK

Provide controllers, integral disconnects, contactors, controls, and control wiring with their respective pieces of system components. Provide electrical system components, including motors and wiring, as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.1.1 Grounding and Bonding

Grounding and bonding must be in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.2 MATERIALS AND SYSTEM COMPONENTS

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that

are of a similar material, design and workmanship. Provide materials and system components that have been in satisfactory commercial or industrial use for a minimum 3 years prior to bid opening. The 3 year period must include applications of the system components and materials under similar circumstances and of similar size. Provide materials and system components that have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 3 year period.

Internal parts and components of system components, piping, piping components, and valves that could be exposed to fuel during system operation must not be constructed of zinc coated (galvanized) metal . Do not install cast iron bodied valves in piping systems that could be exposed to fuel during system operation.

2.3 NAMEPLATES

Attach nameplates to all specified system components defined herein. List on each nameplate the manufacturer's name, address, contract number, acceptance date, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of stainless steel . Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be one by 2.5 inches. Provide manufacturer's storage tank nameplates as required. Lettering must be the normal block style with a minimum 0.25 inch height. Accurately align all lettering on nameplates. Key the nameplates to a chart and schedule for each system. Frame charts and schedule under glass, and locate where directed near each system. Furnish two copies of each chart and schedule. Each nameplate description must identify its function.

2.4 ABOVEGROUND STORAGE TANK

2.4.1 Aboveground Storage Tank (Single Wall Steel)

Provide a factory-welded, single wall stainless steel tank manufactured to UL 142 and equipped to comply with NFPA 30 for use as a flammable or combustible liquid storage tank. Day tanks must be designed and manufactured for a vertical cylindrical installation. Tank must be anchored to the each specific tank foundation per the manufacturers requirements. Tank assembly must have lifting lugs that allow tank relocation. Provide tank assembly with the manufacturer's standard external ladder and catwalk assembly, except as modified herein. The ladder and catwalk assembly must be constructed of structural steel and must allow personal access to the top of the tank system.

2.4.2 Aboveground Lube Oil Storage Tank (Double Wall Steel)

Provide a factory-assembled unit that includes a factory-fabricated primary storage tank and an integral secondary containment. Tank assembly must be in accordance with NFPA 30 and be designed and manufactured for a rectangular installation. Primary storage tank must be factory-welded, steel that conforms to UL 142. Tank assembly must have lifting lugs that allow tank relocation.

2.4.2.1 Double Wall Steel Tank

The secondary containment (outer) tank must be a factory-fabricated, stainless steel type that fully-encloses the primary storage (inner) tank. The entire tank assembly must conform to UL 142 and bear the UL 142

label. The interstitial space between the primary tank and the secondary containment tank must be both pressure testable and verifiable. The primary storage tank must be supported within the secondary containment tank reservoir with steel tank saddles, or other similar supports, fabricated and installed by the tank manufacturer.

2.5 UNDERGROUND STORAGE TANK

Provide a factory-fabricated, double wall type storage tank that conforms to NFPA 30, NFPA 30A, or NFPA 31. Tank must be designed and manufactured for an underground, horizontal installation. The exterior tank walls must be separated from the interior tank walls by standoffs; thus creating an open or interstitial space (Type II). The entire interstitial space must be monitorable for leaks. For tanks requiring concrete anchor pads or concrete deadmen, provide holddown straps and accessories as recommended by the tank manufacturer. Use filler strips between the tank shell and any metal holddown straps that conform to the tank manufacturer's requirements.

2.5.1 Double Wall FRP Tank

Tank must be constructed of fiberglass reinforced plastic (FRP) and must conform to UL 1316. The UL 1316 label must be affixed to the exterior surface of the tank.

2.6 TANK PROTECTIVE COATINGS

2.6.1 Interior Surfaces

Coat 100 percent of a metal tank's interior surfaces including all metal piping and metal appurtenanceswith the manufacturer's standard coating system as modified herein.

2.6.1.1 Certifications of Coating Contractors

All Contractors and Subcontractors that perform surface preparation or coating application must be certified to SSPC QP 3 and SSPC QS 1 prior to contract award, and must remain certified while accomplishing any surface preparation or coating application. Painting contractors and painting subcontractors must remain so certified for the duration of the project. If a contractor or subcontractor certification expires, the firm is not allowed to perform any work until the certification is reissued. Requests for extension of time due to delay as a result of an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in certification status. Notify the Contracting Officer of all scheduled or unannounced on site audits from SSPC and furnish a copy of all audit reports.

2.6.2 Exterior Surfaces, Aboveground Tanks

Protect the exterior surfaces of each aboveground tank with the manufacturer's standard coating system as modified herein as modified herein.

2.6.2.1 Certifications of Coating Contractors

All Contractors and Subcontractors that perform surface preparation or coating application must be certified to SSPC QP 3 and SSPC QS 1 prior to contract award, and must remain certified while accomplishing any surface

preparation or coating application. Painting contractors and painting subcontractors must remain so certified for the duration of the project. If a contractor or subcontractor certification expires, the firm is not allowed to perform any work until the certification is reissued. Requests for extension of time due to delay as a result of an inactive certification will not be considered and liquidated damages will apply. Notify the Contracting Officer of any change in certification status. Notify the Contracting Officer of all scheduled or unannounced on site audits from SSPC and furnish a copy of all audit reports.

2.6.3 Tank Labeling

Tank must be labelled with the following information at a minimum:

a. Product Stored and Tank Capacity (Per MIL-STD-161).

b. Tank Number and Facility Number.

c. NFPA 704 Diamond Hazmat Label.

2.7 TANK COMPONENTS

2.7.1 Tank Manhole

Tank manholes shall follow what is shown in the design drawings. Provide each manhole with a matching flanged watertight manhole cover. Manhole covers must be UL listed, be constructed of pressed or mild steel, and include a UL listed gasket.

2.7.2 Tank Piping Penetrations

Provide a welded-in-place flanged pipe nozzle for each tank piping connection. All unused or spare tank piping penetrations must be sealed with steel flanges .

2.7.3 Tank Striker/Impact Plates

Provide an interior striker/impact plate under each tank manhole and pipe connection. Each plate must be a minimum of 1/4 inch in thickness, be larger in diameter than the tank penetration, fit the curvature of the tank bottom, and be completely coated in the same fashion as the interior tank bottom coating. Each plate must be welded to the tank bottom at the factory (full circumference connection). The welds must be non-destructive tested using the appropriate means.

2.7.4 Manual Gauging/Sampling Hatch

Provide a combination gauging and sampling hatch assembly. The assembly must include a bronze top-seal type adapter with a corresponding locking type cap (adapter and cap both externally-mounted to the top of the tank) and a steel stilling well pipe. The stilling well pipe must be a minimum 4 inches in size and extend downward through the top of the tank to within 3 inches of the tank bottom. Provide the entire length of pipe inside the tank with 1/2 inch wide by 12 inches long slots at alternate locations. Coat the pipe in the same fashion as the interior tank bottom coating.

2.7.5 Tank Ladder

Provide interior tank ladders constructed of either fiberglass for the

50,000 underground storage tanks only. If steel, coat the ladder in the same fashion as the tank interior. The two stringers must be a minimum 3/8 inch thick and a minimum 2 inches wide. The rungs must be a minimum 3/4 inch rod on 12 inches centers. Members of the ladder must be securely affixed. Ladder must be of sufficient length to extend from the bottom of the tank to the top surface of the tank. Ladder must be rigidly connected to the tank bottom in accordance with the tank manufacturer's standard. Ladder must be connected to the top of the tank with pipe guides or slip bars to accommodate expansion of the two stringers.

2.7.6 Tank Venting

2.7.6.1 Atmospheric Vent

Provide atmospheric, updraft type cap. Cap must be constructed of aluminum or carbon steel. Cap must have an internal brass or bronze insect screen, minimum 40-mesh. Cap must prevent rain, snow, or ice from entering the vent piping.

2.7.6.2 Emergency Vent

Vent must be the normally-closed, UL listed type that vents outward and upward. Vent must conform with NFPA 30 and UL 142 and must be sized by the tank manufacturer. Provide vent with rating permanently labeled on the vent's exterior. For double wall or protected type tanks, provide a second emergency vent to protect the interstitial space.

2.8 TANK GAUGES

2.8.1 Stick Gauge

For each tank, provide 2 wooden stick gauges. Gauge length must allow the measurement of the entire level of fuel in the corresponding tank. Gauges must be compatible with the fuel to be measured (no swelling or damage from fuel contact). Provide gauge with non-sparking caps on each end. Mark gauges in feet and inches. The smallest unit of measure on the gauge must be 1/16 inch.

2.8.2 Tank Strapping Table

Furnish 2 tank manufacturercertified strapping tables (calibration charts) for each tank. One of the tables must indicate the liquid contents in for each of tank depth and the other in gallons for 1/16 inch of tank depth. Strapping table volumes for all tanks 5,000 gallons and larger must be determined using physical measurements and not calculated values. For each tank, provide an electronic media file of each strapping table. For tanks larger than 5,000 gallons tank strapping must be performed after installation at the site.

2.8.3 Mechanical Clock Gauge

Gauge must be the level sensing, mechanically actuated type that provides the tank level readout in a sealed glass cap contained in a gauge box. Gauge must be accurate to plus or minus 1/4 inch and must measure the liquid level over the full range of a tank's height. Gauge must have vapor tight seals to prevent condensation from fogging the viewing glass.

2.8.4 Automatic Tank Gauge System (ATG)

Gauge system must be the mechanically or electronically actuated type that can continuously monitor a tank's usable liquid level storage capacity. The system must provide a digital readout of a tank's liquid level in terms of inches and gallons. The system must be accurate to plus or minus 1/16 inch. The system must measure water accumulation in inches from 3/4 to 5 inches off the bottom of a storage tank. Construct system components to be chemically compatible with the fuel to be handled. For each tank monitored, provide a sending unit that transmits the digital readout from a tank to the electronic monitoring/alarm panel defined in Section 33 01 50.31 LEAK DETECTION FOR FUELING SYSTEMS

2.9 MANHOLE CONTAINMENT SUMP

Sump must be the factory-fabricated, direct-buried type that provides a watertight connection either directly to the exterior of the tank or to a flanged manhole opening. All tank manway sumps shall have a polygon sump body. Sump must be constructed of fiberglass reinforced plastic. Sump construction must be chemically compatible with the type of products being handled within the connecting tank. Sump must allow access to a tank manhole cover without disturbing surrounding backfill. Sump must be larger in diameter than the connecting tank manhole. Sump must be designed to withstand the underground burial loads. Sump assembly must prevent the influx of rainfall drainage or ground water.

2.9.1 Piping Penetrations

Sump sides must allow the penetration of carrier pipes, exterior containment pipes, conduits, and vapor pipes as required. All tank manway sumps shall have a polygon sump body. Sump penetrations must be booted to ensure that liquid will not escape from the sump in the event that the liquid level within the sump rises above the pipe penetration. Boots and seals used must be compatible with the fuel to be handled. Boots and seals must be water resistant to the influx of water from outside the sump. Boots and seals must be designed and installed to accommodate the anticipated amount of thermal expansion and contraction in the piping system.

2.9.2 Access Cover

Where indicated, the entire top of a containment sump must be capped with a strapped or screw down, watertight access cover that allows water to flow away from the manhole. Cover must be constructed of the same material as the sump. Cover must have a larger diameter than the tank manhole cover below. Cover must be lightweight and not exceed 35 pounds .

2.10 INSPECTION WELL

Inspection well must be constructed of Schedule 40 PVC pipe that is 6 inches in diameter. Pipe must be factory slotted from the bottom to within 12 inches of grade. With the pipe installed vertically, slots must be horizontal and have a width of 0.02 inch with not less than 30 slots per ft. Slots must encompass at least 80 percent of the pipe's 360 degree perimeter with the pipe maintaining its structural integrity. Slots must allow fluid within the soil to infiltrate into the pipe without allowing sediment to fill the pipe. Each well must extend down 2 ft below the deepest buried storage tank. Well must have a permanently fixed bottom cap. Well must have a removable top cap that is protected from traffic

with a watertight street manhole and cover as indicated. Well must have a 3/8 inch vent hole located directly below the top cap to vent the well. The top cap of each well must be accessible from the surface through a 12 inches diameter manhole. The manhole ring must be constructed of steel, cast iron, or fiberglass, have a cast iron cover, be a minimum of 12 inches deep, and withstand H-20 highway loading as defined by AASHTO HB-17. Each manhole cover must have the words "DO NOT FILL - INSPECTION WELL" cast permanently into the top. The letters must be a minimum of 1/2 inch in size. Each manhole cover must have a white circle with a black triangle painted on the surface.

2.11 ACCESSORIES

2.11.1 Concrete Anchor Bolts

Concrete anchors must conform to ASTM F1554, hot-dipped galvanized.

2.11.2 Bolts and Studs

Carbon steel bolts and studs must conform to ASTM A307, Grade B, hot-dipped galvanized. Stainless steel bolts and studs that conform to ASTM A193/A193M, Grade 8.

2.11.3 Nuts

Carbon steel nuts must conform to ASTM A563, Grade A, hex style, hot-dipped galvanized. Stainless steel nuts must conform to ASTM A194/A194M, Grade 8.

2.11.4 Washers

Provide flat circular washers under each bolt head and each nut. Washer materials must be the same as the connecting bolt and nut. For ASTM F1554 concrete anchors, use ASTM F436, Type 1, hot-dipped galvanized washers. For ASTM A307 bolts and studs, carbon steel washers must conform to ASTM F844, hot-dipped galvanized. Stainless steel washers must conform to ASTM A194/A194M, Grade 8.

2.11.5 Polytetrafluoroethylene (PTFE) Tape

Tape must conform to ASTM D3308.

2.11.6 Street Manhole Assembly

Round street manhole frames and covers must be the straight traffic type. Frames and covers must be constructed of cast steel in accordance with ASTM A27/A27M, grade 60-30 as a minimum. Covers must be the solid plate type with a checker pattern. Covers must form a watertight seal with the manhole frame to prevent surface water inflow. Frame and cover assembly must be rated to withstand H-20 highway loading as defined by AASHTO HB-17.

PART 3 EXECUTION

3.1 INSTALLATION

Install work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Handle storage tanks with extreme care to prevent damage during placement and install in accordance with the manufacturer's installation instructions and NFPA 30, NFPA 30A,

or NFPA 31 as applicable. Inspect the exterior surface of each tank for obvious visual damage prior to and during the placement of each storage tank. Repair surface damage to a storage tank according to manufacturer's requirements before proceeding with the system installation. Provide the termination of fill lines within a tank with an antisplash deflector. Provide nylon dielectric bushings on pipe connections to a steel tank.

3.1.1 Underground Storage Tank

Install underground storage tanks in accordance with API RP 1615 except as modified herein. Place tank on a 1/8 inch per foot slope with the fill point at the low end and the vent connection at the high end. Locate tank so that the fuel discharge pipes slope up uniformly toward the fuel outlet. Install containment sumps prior to any backfill being added above the storage tanks.

3.1.1.1 FRP Underground Storage Tank Handling

Handle tank with extreme care to prevent damage during installation and transportation to the site. Any damaged tank must be replaced or repaired and tested under direct supervision and advice of the tank manufacturer, using the manufacturer's written procedures.

3.1.1.2 FRP Underground Storage Tank Installation Procedures

Set tank on a minimum of 12 inches of backfill material. Anchor tank to a reinforced concrete anchor pad as indicated through the use of manufacturer's supplied holddown straps. Separate tank from an anchor pad by a minimum of 12 inches of backfill material.

3.1.2 Aboveground Storage Tank

Install aboveground storage tanks in accordance with STI 700-50-5007 (STI R912) except as modified herein. Place tank that is less than 5,000 gallons on a level surface. Day tanks shall be anchored to the tank foundations per the manufacturers requirements.

3.1.2.1 Steel Aboveground Storage Tank Handling

Store, handle, and place externally coated steel tanks with care and in a manner that will minimize damage to the coating and will not reduce its protective value. Place coated tanks in position carefully and with a minimum amount of handling. Repair any damaged tank coating in accordance with the appropriate UL or STI standard (UL 1746, STI 020-50-1000, or UL 58). Do not move the tank unless it is empty.

3.1.2.2 Steel Aboveground Tank Installation Procedures

Tanks should be secured to the associated tank pad per tank manufacturer's recommendations using fasteners installed through the tank anchor chairs. Perform seismic analysis of the tanks as nonstructural components per UFC 3-301-02 section 2-17 to determine if tanks are susceptible to sliding or overturning.

3.1.3 System Components

Properly level, align, and secure system components in place in accordance with manufacturer's instructions. Provide supports for system components, appurtenances, and pipe as required. Install anchors, bolts, nuts,

washers, and screws where required for securing the work in place. Sizes, types, and spacings of anchors and bolts not indicated or specified must be as required for proper installation.

3.2 FIELD QUALITY CONTROL

3.2.1 Aboveground Storage Tank Tightness Tests

Perform tightness tests on each aboveground storage tank prior to making piping connections. Perform testing in accordance with STI 700-50-5007 (STI R912)except as modified herein. Gauges used to monitor the tests must have a scale with a maximum limit of 15 psig. Repair leaks discovered during the tightness tests in accordance with tank manufacturer's instructions. Following any repair, re-test the tank until the tank successfully passes the testing requirements of this paragraph.

3.2.2 Underground Storage Tank Tightness Tests

Perform a tightness test on each underground storage tank on-site just prior to their placement into the ground. Pneumatically pressurize each storage tank's primary chamber to 5 psig and monitor for a drop in pressure over a 2-hour period during which there must be no drop in pressure in the tank greater than that allowed for thermal expansion and contraction. Following the successful completion of the primary chamber test, bleed the pressure from the primary chamber into the interstitial space. Maintain this pressure while applying soapsuds or equivalent material over the exterior of the tank. While applying the soapsuds, visually inspect the entire tank, including the bottom surfaces, for leaks (bubble formations). Inspection of the bottom surfaces of a tank may be performed by rotating the tank; however, a tank must only be rotated in strict accordance with the manufacturer's recommendations. Do not rotate a tank more than 90 degrees from the upright position. During testing, install a pressure relief device that relieves at the tank manufacturer's suggested pneumatic pressure limit. Gauges used in pneumatic tests must have a scale with a maximum limit of 15 psig.

3.2.2.1 Brine Level Test

In lieu of the pneumatic testing procedures described above, a brine level test may be performed on the interstitial space of double-walled FRP tanks (not applicable to steel tanks). For a brine level test, completely fill a FRP tank's interstitial space with a brine solution. Connect a riser pipe to the interstitial space that will allow the solution to rise within the riser at least 12 inches. After filling the interstitial space, the tank must set approximately 3 hours. Following the 3-hour period, measure and record the level of solution within the riser. After a subsequent 4-hour period, again measure and record the level of solution within the riser. If the level of solution within the interstitial decreases anytime during the test, the tank is considered leaking and therefore fails the test.

3.2.2.2 Repairs

Repair leaks discovered in either the primary chamber or the interstitial space in accordance with the tank manufacturer's instructions. Following any tank repairs, re-test the tank until the tank successfully passes the testing requirements defined herein.

3.2.3 Tank Manufacturer's Tests

In addition to the tests required herein, perform any additional tests (i.e., leak tests, cathodic protection verification tests, etc.) on each storage test that is required by the tank manufacturer's written test procedures. Manufacturer's tests that are redundant to tests already required by this specification will only be performed once per tank. Repair all leaks discovered during the tests in accordance with manufacturer's instructions. Following tank repairs, re-test the tank until the tank successfully passes the manufacturer's testing requirements.

3.2.4 System Commissioning

System commissioning must conform to Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT) .

3.2.5 Tank Inspection Reports

Prior to system commissioning, a STI SP001 certified inspector must inspect the completed underground tank in accordance with STI SP001 and deliver a full report to the Contracting Officer. The report must include a record of ultrasonic thickness measurements (UTMs), exclusive of the coating, of each single wall underground tank shell. The report must include the tank dataplate information and photograph of the tank data plate. Provide electronic copies of the tank inspection reports to Service Headquarters and Service Control Points. The paper and electronic copies of the report and UTMs must be provided to the Contracting Officer for filing with the tank's "as-built drawings." Refer to Section 01 45 00 QUALITY CONTROL for STI SP001 Inspector's Certification requirements.

3.3 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the system components and systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/system components and systems, both operational and practical theories, and associated routine maintenance procedures. The training session must consist of a total of 3 hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the onsite training. Personnel that are responsible for daily operation and maintenance of undergound storage tanks (UST) and associated system require class A/B/C UST operator training from a state-approved program. The tanks will require monthly, annual and periodic professional evaluations of the tank integrity, line leak detection and tank manway equipment.

3.4 Tank Fill Tests

Tank fill tests must not be performed until after the flushing, cleaning, and adjusting requirements defined in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). For the tank fill tests, initially fill each storage tank with fuel in order to verify the tank level alarm system operates properly and the tank overfill protection device functions as designed. Stop filling each tank immediately once the overfill devices operates. Do not overfill any storage tank more than the 98 percent

level. Drain the system below the low liquid level setpoint to verify operation of the low level alarm. Correct and retest any problems with the level alarm system or the overfill device until each operate as specified herein. During the tests, verify that all tank gauges are calibrated and operating appropriately.

3.5 FIELD PAINTING

Painting required for surfaces not otherwise specified must be field painted as specified in Section 09 90 00 PAINTING, GENERAL. Do not paint stainless steel and aluminum surfaces. Do not coat system components or components provided with a complete factory coating. Prior to any field painting, clean surfaces to remove dust, dirt, rust, oil, and grease.

-- End of Section --

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SECTION 33 57 55

FUEL SYSTEM COMPONENTS (NON-HYDRANT)
11/18, CHG 1: 11/20

PART 1 GENERAL

1.1 SUMMARY

This section defines the requirements for system components as related to a non-hydrant fuel distribution system. Provide the entire fuel distribution system as a complete and fully operational system. Size, select, construct, and install equipment and system components to operate together as a complete system. Substitutions of functions specified herein will not be acceptable. Coordinate the work of the system manufacturer's service personnel during construction, testing, calibration, and acceptance of the system. System components and piping specified herein must be designed to handle a working pressure of 285 psig for stainless steel systems at 100 deg F. Components specified herein must be compatible with the fuel to be handled. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between -20 degrees F and 120 degrees F.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 540	(1999; R 2004) Electrical Installations in Petroleum Processing Plants
API RP 1615	(2011) Installation of Underground Petroleum Storage Systems
API RP 2003	(2015; 8th Ed) Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents
API STD 610	(2010; Errata 2011) Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A182/A182M	(2023) Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A276/A276M	(2024) Standard Specification for Stainless Steel Bars and Shapes
ASTM A487/A487M	(2024) Standard Specification for Steel Castings Suitable for Pressure Service
ASTM A582/A582M	(2022) Standard Specification for Free-Machining Stainless Steel Bars
ASTM A743/A743M	(2021) Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM C827/C827M	(2023) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2017) Standard Test Procedure for Polyphase Induction Motors and Generators
IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment

HYDRAULIC INSTITUTE (HI)

HI M100	(2009) HI Pump Standards Set

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024) Flammable and Combustible Liquids Code
NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code
NFPA 77	(2024) Recommended Practice on Static Electricity
NFPA 407	(2022; TIA 21-1) Standard for Aircraft Fuel Servicing

NFPA 780	(2023) Standard for the Installation of Lightning Protection Systems

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS3275	(2009; Rev C) Sheet, Acrylonitrile Butadiene (NBR) Rubber and Non-Asbestos Fiber Fuel and Oil Resistant

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-25896	(1983; Rev E; Notice 1 1989; Notice 3 2003) Adapter, Pressure Fuel Servicing, Nominal 2.5 inch diameter
MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for
MIL-DTL-83413	(2012; Rev C; AMD 1 2017; AMD 2 2019) Connectors and Assemblies, Electrical, Aircraft Grounding, General Specification for
MIL-DTL-83413/4	(2018; Rev E; AMD 1 2018) Connectors and Assemblies, Electrical, Aircraft Grounding: Plugs, for Types I and II Grounding Assemblies
MIL-PRF-4556	(1998; Rev F; Am 1 1999; CANC Notice 1 2011) Coating Kit, Epoxy, for Interior of Steel Fuel Tanks
MIL-STD-130	(2007; Rev N; Change 1 2012) Identification Marking of U.S. Military Property
MIL-STD-161	(2015; Rev H) Identification Methods for Bulk Petroleum Products Systems Including Hydrocarbon Missile Fuels

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-50696	(2016; Rev D) Reels, Static Discharge, Grounding, 50 and 75 Foot Cable Lengths
CID A-A-59326	(Rev D) General Specification For Coupling Halves, Quick-Disconnect, Cam-Locking Type

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 280	Technical Standards and Corrective Action

Requirements for Owners and Operators of Underground Storage Tanks (UST)

1.3 ADMINISTRATIVE REQUIREMENTS

Submit detail drawings consisting of illustrations, schedules, performance charts, instructions, brochures, diagrams, and other information to illustrate the requirements and operation of the system components and systems. Provide the drawings as one package with the design analysis. Shop fabrication drawings must include type of material, configuration, thickness, and necessary details of construction of the steel tank and vault. Shop drawings must also show the steel grating and supports. Submit Manufacturer's Catalog Data and Certificates of Compliance. Operation and maintenance information must be submitted for the system components items or systems listed in PART 2. Automatic pump controls must include step-by-step procedures required for system startup, operation, and shutdown.

1.4 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Grounding and Bonding; G, RO

Meters; G, DO

Packaged Truck Offload System; G, DO

High Point Vent and Low Point Drain Pits; G, DO

SD-03 Product Data

Pressure Gages; G, DO

DIFFERENTIAL PRESSURE GAUGE; G, DO

Automatic Pump Controls; G, DO

Flow Switches; G, DO

Meters; G, DO

Submersible Pump; G, DO

Gear Pump; G, DO

Packaged Truck Offload System; G, DO

Filter/Separator; G, DO

High Point Vent and Low Point Drain Pits; G, DO

FRP Containment Sump; G, DO

Liquid Level Gauge; G, DO

Operating Tank Level Switches; G, DO

Lube Oil Dispenser; G, DO

SD-06 Test Reports

SD-07 Certificates

System Supplier; G, RO

SD-10 Operation and Maintenance Data

Automatic Pump Controls; G, RO

Meters; G, RO

Submersible Pump; G, RO

Gear Pump; G, RO

Packaged Truck Offload System; G, RO

Filter/Separator; G, RO

1.4.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.5 QUALITY ASSURANCE

Submit the following data for approval:

a. Certification stating that the System Supplier has provided and installed at least five Programmable Logic Control (PLC)-based pump control systems in the last five years, for automatic cycling of pumps based upon varying dispensing demands, utilizing multiple pumps. These systems must be for dispensing Diesel .

b. Certification that six systems have been successfully operated over the last three years and are currently in service.

c. Project names, locations, system description, and items provided at these installations. Include user point-of-contact and current telephone numbers.

1.5.1 Material and Equipment Qualifications

Provide materials and system components that are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship. Materials and system components must have been in satisfactory commercial or industrial use for a minimum two years prior to bid opening. The two year period must include applications of the system components and materials under similar circumstances and of similar size. Materials and system components must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the two year period.

1.5.2 Nameplates

Attach nameplates to all specified system components, thermometers, gauges, and valves defined herein. List on each nameplate the manufacturer's name, address, contract number, acceptance date, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Construct plates of stainless steel . Install nameplates in prominent locations with nonferrous screws, nonferrous bolts, or permanent adhesive. Minimum size of nameplates must be 1 by 2-1/2 inches. Lettering must be the normal block style with a minimum 1/4-inch height. Accurately align all lettering on nameplates. Key the nameplates to a chart and schedule for each system. Frame charts and schedule under glass, and locate where directed near each system. Furnish two copies of each chart and schedule. Each nameplate description must identify its function.

1.6 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect system components and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

PART 2 PRODUCTS

If gasoline is being handled, refer to 40 CFR Part 60 Subpart Kb and XX, 40 CFR Part 63 Subpart R, BBBBBB, and CCCCCC for design, installation, and testing requirements.

2.1 MATERIALS

Materials of construction must be stainless steel, aluminum or nonferrous material except positive displacement meter case may be steel with electroless nickel plated internals coated to 3 mil thickness, or interior epoxy coating. No ferrous or zinc-coated material bronze, brass or other copper bearing alloys must be used in contact with the fuel. Do not install cast iron bodied valves or system components. Do not use aluminum valves.

2.1.1 Types of Fuel

Components must be suitable for use with Diesel, DS1/2 fuel. Components to be ANSI Class 150 (275 psig at 100 degrees F) unless noted otherwise. Components to be suitable for outside, unsheltered location, and to function normally in ambient temperatures between -20 degrees F and 120 degrees F.

2.1.2 Composition of Materials

Materials in contact with the fuel must be noncorrosive. No zinc-coated metals, brass, bronze, iron, lead or lead alloys, copper or copper alloys, or other light metal alloys containing more than 4 percent copper must be used in contact with the fuel.

2.1.3 Gaskets

Gaskets must be in accordance with Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

2.1.4 Bolts and Nuts

Bolts and nuts must be in accordance with Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

2.1.5 Flanges

Flanges and flanged end system components must be in accordance with Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT).

2.1.6 Nitrile Butadiene (Buna-N)

Provide Buna-N material that conforms to SAE AMS3275.

2.1.7 Acrylonitrile Butadiene Rubber (NBR)

Provide NBR material that conforms to SAE AMS3275.

2.2 SYSTEM COMPONENTS AND MATERIAL

2.2.1 General

All items of system components and material must be new and of the best quality used for the purpose in commercial practice and must be products of reputable manufacturers. Each major component of the system components must have the manufacturer's name, address and catalog number on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable. The gears, couplings, projecting set screws, keys and other rotating parts located so that any person may come in close proximity thereto must be fully enclosed or properly guarded. System Components, assemblies and parts must be marked for identification in accordance with MIL-STD-130 and MIL-STD-161. Pump and filter vessel numbers must be as indicated on the drawings. In addition, filter vessels must include element numbers and the date of the next element change. Identification tags made of brass, stainless steel, or engraved anodized aluminum, indicating valve number and normally open (NO) or normally closed (NC) must be installed on valves. Tags must be 1-3/8 inch minimum diameter, and marking must be stamped or engraved. Indentations must be black, for reading clarity. Tags must be attached to valves with No 12 AWG, copper wire, stainless or aluminum hanging wires, or chrome-plated beaded chain designed for that purpose.

2.2.2 System Supplier

Since the pump control system, including but not limited to pump control panel, , transmitters, flow switches, fueling system pumps, all field instrumentation, tightness monitoring system, and control valves with all

hardware and software, is an integrated system it must be furnished by a single systems supplier regularly engaged in the supplying of these system components. System Supplier must be a company whose regular, normal, and primary business is representing manufacturers in the distribution and start-up of aviation fueling facilities, and have no affiliation with the Contractor other than as a seller to the Contractor. Supplier must provide all system components and appurtenances regardless of manufacture, be a factory authorized certified representative, and be responsible to the Contractor for satisfactory operation of the entire system, and must oversee the installation of the system components. Substitutions of functions specified will not be acceptable. The Contractor and the System Supplier must be present at the system commissioning, and must coordinate and schedule the work during construction, testing, calibration, and acceptance of the system. The System Supplier must be on-site with their mechanical and control personnel to supervise and assist the contractor during pre-commissioning check-out of the mechanical systems and control systems, initial fuel receipt, initial filing, hydrostatic testing, pigging, flushing, cleaning, system component tests, performance testing and all training for the owner's representatives. The System Supplier must be responsible to the Contractor for scheduling all Contractor, Sub-contractor, and manufacturer's service personnel during system start-up and final commissioning.

2.3 ELECTRICAL

Motors, manual or automatic motor control system components except where installed in motor control centers, and protective or signal devices required for the operation specified herein must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Any wiring required for the operation specified herein, but not shown on the electrical plans, must be provided under this section in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.3.1 Grounding and Bonding

Ground and bond in accordance with NFPA 70, NFPA 77, NFPA 407, NFPA 780, API RP 540, API RP 2003, IEEE 142, and IEEE 1100. Provide jumpers to overcome the insulating effects of gaskets, paints, or nonmetallic components.

2.4 PRESSURE GAGES

Pressure gages must conform to ASME B40.100 with metal cases and 4-inch diameter white dials. Gages must be bottom connected, without back flanges. A pulsation dampener, adjustable to the degree of dampening required, must be provided for each gage. Range of gages must be as indicated. A ball valve must be provided for each pressure gage. Gages must have all parts immersed in glycerin oil. Gages must be labeled with the calibration date.

2.4.1 Quick Disconnect

If indicated on drawings provide quick disconnect on pressure gauge. Quick disconnects for pressure gauges must be double shut-off, dry-break design, 316 stainless steel construction, with Fluorocarbon (Viton) seals, minimum working pressure of 1000 psig at 100 degrees F, with 1/2-inch female NPT threaded connections for both coupler and adapter, manufactured in accordance with ISO 7241, Series B. The quick disconnect assembly must consist of a coupler, half to be connected to the pressure snubber under

the pressure gauge, and a nipple/adapter half to be connected above the pressure gauge isolation ball valve. The nipple/adapter is to be provided with an aluminum dust cap to protect the fitting when the gauge is removed.

2.5 DIFFERENTIAL PRESSURE GAUGE

The gauge must consist of a spring-supported, corrosion resistant piston moving inside a glass cylinder, with high pressure applied on top of the piston and low pressure applied below it. Under a differential pressure of 30 psi, leakage past the piston must not exceed 120 drops per minute. The cylinder and flanges must be stainless steel with Viton O-ring seals. The high pressure inlet of the gauge must have a 10-micron pleated paper filter and the low pressure connection must have a fine mesh stainless steel strainer. The gauge must have an operating pressure of 300 psi. Differential pressure range of the gauge through approximately 3-inches of piston movement must be 0-30 psi with an accuracy of plus 0.5 psi, calibrated linearly with one PSI scale graduations. High and low pressure connections must be 1/4-inch NPT female with a stainless steel bar stock valve at each connection. Construction of the gauge must be such that a 3-valve manifold is not necessary. If only one bar stock valve is closed, the gauge must not be damaged by up to 300 psi differential pressure in either direction. A pressure gauge must be attached to the differential pressure gauge to indicate the high pressure and have a range of 300 psi.

2.6 AUTOMATIC PUMP CONTROLS

The control system components specified in this paragraph must be obtained from a single supplier of such products (see the paragraph SYSTEM SUPPLIER in this section for the requirements). The supplier must be responsible for furnishing components that are compatible and that operate as a system to perform the required pump control functions. Control tubing between controls/instruments and fuel lines must be installed to eliminate air entrapment. Control tubing must be as specified in Section 33 52 40 FUEL SYSTEMS PIPING (NON-HYDRANT). Each system component specified hereafter must have manufacturer's authorized service personnel present to assist in PERFORMANCE TESTING as specified in Section 33 08 55 FUEL DISTRIBUTION SYSTEM START-UP (NON-HYDRANT). Items specified under this paragraph must be submitted for approval concurrently with items specified in Section 33 09 52 FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT).

Electrical supply and electrical control system components must be suitable for the location and area classification in which they are installed. All mounting hardware must be corrosion resistant.

2.6.1 Pump Control System

Provide a system that is furnished by a Single System supplier. System must include all required hardware and software in an integrated system. System must include the operator's interface computer and all required transmitters. System must monitor and control the following as a minimum:

a. Control valves

b. Over the road tank truck offloading system

c. Tank truck ground verification unit

d. Transfer pipeline pumping system

2.6.2 Pump Control Panel

See Section 33 09 52 FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (NON-HYDRANT).

2.6.3 Control Stations

Electrical supply and electrical control system components must be suitable for the location and area classification in which they are installed. All mounting hardware must be corrosion resistant.

2.6.3.1 Pump Control Start/Stop Station

Station must consist of an enclosure, start/stop pushbuttons and green indicator lights as required. Enclosure must be corrosion resistant. In hazardous areas, enclosure must be electrogalvanized iron alloy with factory coating or copper-free aluminum. In non-hazardous areas, enclosures must be galvanized steel, stainless steel, electrogalvanized iron alloy with a factory coating or copper-free aluminum. Pushbutton contacts must have a minimum rating of 10 A, 125/250 VAC. Contact configuration must be as required or indicated. Indicator lights must be LED.

2.6.3.2 Emergency Fuel Shut-Off (EFSO) Station

Enclosure must be corrosion resistant. In hazardous areas, enclosure must be electrogalvanized iron alloy with factory coating or copper-free aluminum. In non-hazardous areas, enclosures must be galvanized steel, stainless steel, electrogalvanized iron alloy with a factory coating or copper-free aluminum. All enclosures must be provided with a hinged glass or polycarbonate front and an open bottom. Paint the enclosure red. Mounting hardware must be corrosion resistant. Mount an emergency pushbutton inside the station housing. Pushbutton must be accessible through the hinged front. Pushbutton must be a momentary contact single unit with a jumbo mushroom operator, 1-NC and 1-NO contact. Mount a caution sign beside the emergency shutdown station, with red 2-inch letters stating "EMERGENCY SHUTDOWN". The sign must have white background and be of noncorrosive construction.

2.6.4 Flow Switches

Switches must be actuating vane type flow switch with single adjustable set-point. Switches must mount on ASME B16.5 Class 150 raised face flange. Flange material must match the piping material at their connection to the system. Provide snap action switch mechanism U.L. listed for Class I, Division 1, Group D hazardous locations. Switches to be double pole double throw (DPDT). Switch power must be 120 volts, single phase, 60 hertz, 10 amps minimum. Units installed on 2-inch piping and smaller may be threaded.

2.7 METERS

2.7.1 Positive Displacement Meters

Meter must be a one-way flow, temperature compensating, positive displacement type meter designed for a continuous flow of 300 GPM at the truck offload. Meter must have ANSI Class 150 flanges and body working pressure of not less than 275 psig and must be suitable for hydrostatic testing of 275 psig . Meter must be factory calibrated for Diesel and

capable of being calibrated in the field. The register must have a non-setback total indicator and a setback type run indicator so that individual runs can be registered without affecting the total of all runs as shown on the indicator. The total indicator must have a minimum of eight figures and the setback run indicator must have a minimum of five figures. The register must read in gallons and the smallest unit of indicated delivery must be one gallon. Accuracy must be within plus/minus 0.3 percent between ten percent and maximum rated flow. Meters must be provided with a suitable drain at the bottom, equipped with a ball valve. Pressure loss through the meter must not exceed 3 psi at 300 GPM flow rate. Meter must have electronic head with means to remotely transmit the quantities passing through it by electronic pulse transmitters mounted on each meter. Materials of construction must be stainless steel, aluminum, or carbon steel with electroless nickel plated or interior epoxy coated internals. The epoxy coating must be in accordance with MIL-PRF-4556.

2.8 MISCELLANEOUS USE PUMPS

Pumps must be driven by an explosion-proof motor for Class I, Division l, Group D hazardous locations as defined in NFPA 70. Pump assemblies must be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow. Pump motors must be non-overloading throughout their entire pump curve.

2.8.1 Submersible Pump (IP-F1 through IP-F4 and IP-O1 through IP-O4)

Pump must be the single-stage, vertical type. Pump and motor combination must operate totally submerged in the product of the storage tank. Pump must extend within 6-inches of the storage tank bottom. Pump fuel inlets must be horizontal. Pump mounting must completely support both the weight and vibration of the pump. Pump must include a steel lifting lug capable of supporting the weight of the entire pump and motor assembly. Pump must include a vertical solid shaft motor, base mounting flange, horizontal pump discharge, low net positive suction head (NPSH) first stage impellers, and dynamic and thrust balancing of impellers. Pump must be accessible for servicing without disturbing connecting piping. Pump baseplate, casing, and bearing housing must be of cast iron construction. Pump must be provided with a stainless steel one piece pump shaft. Internal pump components in direct contact with the fuel to be handled must be of compatible construction. Pump bearings must be selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Provide pump with flanged end piping connections.

2.8.2 OFFLOAD PUMP

2.8.2.1 Capacity

Capacity must be 300 gpm against a total head of 50 feet when driven at 3600 rpm. Overall efficiency at design conditions of pump and driver, connected, must be minimum of 60 percent. Pump head capacity must be continually rising and must be free of dips and valleys from design point to shut-off head. Pump shut-off head must have a 10 to 20 percent head rise to shut off. Pump must be capable of at least a 10 percent head increase at rated conditions by installing a new impeller. Pumps must not overheat or be damaged in any way while operating continuously at a minimum flow condition of 150 gpm and continuously at a maximum flow condition of 125 percent required capacity GPM. The unit will also be required to operate at a flow of 12.5 percent required capacity without exceeding the vibration limits given in API STD 610. These pumps are for

parallel operation and must have equal head at minimum continuous stable flow, plus or minus 2 percent.

2.8.2.2 General Requirements

a. The pumps for this service must meet the requirements of API STD 610, latest edition. Whenever the information contained herein conflicts with said standard, the information here in must govern. The pumps for this service must run at a nominal 3600 rpm and must be single stage centrifugals, horizontally mounted, vertical or radial split case, enclosed impeller, vertical-in-line with end suction and discharge. All parts must be factory inspected so that parts are interchangeable. Pumps and motors must be furnished as complete units as herein specified. Pump assembly must be statically and dynamically balanced for all flow rates from no flow to 120 percent of design flow.

b. The pump must require no more than 15.5-feet of net positive suction head (NPSHR) when it is operated with water at a capacity of 600 gpm at rated head and speed. A hydrocarbon reduction or correction factor must not be used. Pump suction specific speed must be less than 12,000.

c. The pump must be vertical in-line, single stage, single suction with double volute construction to assure radial balance. It must be designed to permit removal of the impeller, shaft, bearings and bearing housing as an assembly, without disconnecting the suction or discharge piping. Pump must be designed to remove the mechanical cartridge seal without removing the motor.

d. The pump case must be vertical in-line type for ease of piping alignment. Flange ratings must be class 300-pound per ASME B16.5. The case must be designed for maximum discharge pressure at pumping temperature but not less than 550 psig, with a minimum corrosion allowance of 1/8-inch. The suction and discharge flanges as well as the cover bolting surfaces must be backfaced or spotfaced for positive bolt seating. The radial case to cover split must be a metal-to-metal fit with a confined, controlled compression gasket.

e. The pump cover must contain a stuffing box designed to accept an unbalanced mechanical seal. The stuffing box must have a minimum of 3-inch studs for seal gland bolting. The gasket fit for seal gland to stuffing box must be of the controlled compression type with metal-to-metal joint contact.

f. Both case and cover are to be fitted with renewable wear rings.

g. The impeller must be of the enclosed type, dynamically and hydraulically balanced. It must be key driven, held in place by a positive lock, threaded against rotation.

h. Mechanical Seal. A single unbalanced mechanical seal per API STD 610 code USTHN of multiple spring design must be supplied. The seal gland must be tapped for three connections and each must be stamped for identification as follows: Q for quench; F for flush; and D for drain. A non-sparking throttle bushing pressed into the seal end plate against an outside shoulder must be provided to minimize leakage on complete seal failure.

i. Bearing Housing. Grease lubricated anti-friction, radial and thrust bearings of standard design must be supplied. The bearings must be

selected to give a minimum L-10 rating life of 25,000 hours in continuous operation. Pumps may be provided with or without bearing brackets.

j.Shafts must be of ample size to transmit the maximum torque required under specified operating conditions, and to withstand continuously all stresses resulting from supported weights, thrusts and starting, including across-the-line motor starting. It must be key seated to provide positive drive for the line motor starting. It must be key seated to provide positive drive for the coupling, shaft sleeve and impeller. The shaft stiffness factor must be under 70. The radial bearing centerline to impeller centerline, distance and the pump shaft diameter under the sleeve must be provided to calculate the factor.

k. A rigid type spacer coupling must be supplied. The spacer length must permit the removal of the assembled pullout element without disturbing the driver or the suction and discharge piping. Couplings must be properly keyed in place. Cylindrical fits must be light enough to permit easy removal of the hub in the field without the need for heating. A service factor of at least 1.5 must be used in selecting couplings based on manufacturer's ratings.

l.Removable coupling guards of the non-sparking type must be supplied. They must comply with the requirements of OSHA.

m.Total indicated shaft runout at coupling end must be 0.001-inches or less. Total shaft deflection must be no more than 0.002-inches at face of stuffing box.

n. Materials. No zinc, brass, bronze or other copper bearing alloy must come in contact with the fuel.

o.The case and cover must be constructed of stainless steel ASTM A487/A487M GR CF8M or ASTM A487/A487M GR CA6NM

p.Impeller material must be stainless steel ASTM A487/A487M GR CF8M or ASTM A743/A743M CA 6NM.

q.Wear rings must be stainless steel ASTM A182/A182M GR F6 or ASTM A276/A276M TP410 or 416 or ASTM A743/A743M CA15 HT-403.

r.Shaft must be stainless steel ASTM A276/A276M type 410 or 416 or ASTM A582/A582M Type 410 or 416 with renewable shaft sleeve of ASTM A276/A276M type 316L with hard facing under mechanical seal gasket.

s.Testing. All shop testing must be performed in accordance with the HI M100.

2.8.2.3 Service Nameplate

A pump service nameplate, of type 18-8 stainless steel or monel, attached by stainless steel pins at an accessible point on the pump, must be furnished in addition to the identification nameplate. The pump service nameplate must be stamped with the following information:

Manufacturer's name
Serial number of pump
Capacity, gpm

Pumping head, ft.
Maximum specific gravity of fluid to be pumped
Revolutions per minute
Horsepower of driver

2.8.2.4 Identification Nameplate

A pump identification nameplate of Type 18-8 stainless steel or monel must be provided and securely attached by stainless steel pins to a conspicuous place on the pump head. Tagging in letters 1/4-inch high must bear the equipment number as shown on the drawings.

2.8.2.5 Exterior Primer Coat

Exterior surfaces of the baseplate must be primed by the manufacturer. Coating must be applied meeting requirements of SSPC PA 1. Surface cleaning must meet requirements of SSPC SP 10/NACE No. 2. Metal primer must be zinc rich paint conforming to specification MIL-DTL-24441, Type 1, Class 3. Dry film thickness must be 2 to 4 mils.

2.8.2.6 Exterior Topcoat

Manufacturer's standard exterior topcoat must be applied at factory to the base plate.

2.8.2.7 Motors

a. Motor must be furnished by the pump manufacturer and must be suitable for the environment and operating conditions to which it will be subjected. Provide space heaters suitable for operation on 460 or 120 volts as indicated on the drawings within the motor enclosure to prevent moisture condensation after shut-down. Motor must be UL listed for use in Class 1, Division 1, Group D hazardous areas, and must have a maximum temperature rating of T2D (419 degrees F) as defined by NFPA 70. The motor nameplate must include the temperature rating of the motor and locked-rotor indicating code letters in accordance with NFPA 70, Table 430-7(b).

b. Voltage rating must be 460 volts, 3 phase, 60HZ. Motor nominal speed must match pump. Motors must be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10 percent above or below rated voltage.

c. Pump manufacturer must assure the specified output and proper operation of the pump without being overloaded at unity service factor when operating at any point on the pump performance curve. In addition to having sufficient horsepower-output rating at rated speed, motor must have performance characteristics which will allow, without injurious overheating of the motor, accelerating the load from standstill to rated speed under conditions of 10 starts per hour. Attention is specifically directed to the fact that thermal characteristics of motors with regard to capability for accelerating the load may vary greatly from motor manufacturer to motor manufacturer, notwithstanding that the horsepower rating may be the same. It is the pump manufacturer's responsibility to provide motors with adequate thermal starting characteristics as well as adequate rated-speed operating characteristics. Service factors must conform with NEMA standards; however, service factors are only applicable at rated nameplate voltage and frequency. Since all system voltages are subject to

variation, service factors above unity must not be applied in sizing motor.

d. Motor must be squirrel-cage induction type. Motor must be NEMA Design B (normal-torque, low starting current).

e. Motor insulation must be non-hydroscopic, NEMA Class F, 300 degrees F for motors. Stator windings must be epoxy impregnated. The impregnations must be applied by the vacuum and pressure process.

f. Winding temperature rise, (based on a maximum ambient temperature of 104 degrees F at 3300-feet altitude) must not exceed 176 degrees F.

g. Bearings must be ABMA minimum L10 life of 60,000 hours or L50 life of 300,000 hours suitable for the size, type, and application when the pump is operating at the specified flow and head.

h. Motor enclosures must be totally enclosed, weather sealed, fan cooled, explosion-proof and must be listed and labeled for Class 1, Group D areas. Provide bronze ground bolt on motor enclosure. All motor external electrical connections must be terminated within a single terminal housing.

i. The dynamic balance, overspeed withstand capability, and sound power levels of the motor must conform with NEMA standard requirements.

j. The pump manufacturer must furnish the Contracting Officer with the recommended minimum run time for the motor.

k. Pump motor must be provided with temperature limiting thermostats within the motor frame when required to meet Class 1, Group D requirements.

l. Pump motor must be furnished with lifting lugs on the motor casing.

m. Unless indicated otherwise, motors for conventional applications over 15 horsepower must be the premium efficient type. This requirement is not applicable to hermetically sealed motors, integrally mounted motors, motors specified as part of energy efficient equipment, wound rotor motors, or any application involving special construction or performance. Guaranteed minimum full load efficiencies must be (based on 3600 rpm, 2 pole totally enclosed):

20 hp	92.0 percent	75 hp	95.5 percent
25 hp	92.0 percent	100 hp	93.5 percent
30 hp	92.0 percent	125 hp	94.5 percent
40 hp	92.0 percent	150 hp	94.5 percent
50 hp	92.5 percent	200 hp	94.5 percent
60 hp	92.5 percent	500 hp	94.5 percent

n. Other motors of different speed or housing classification must also be of the premium efficient type, as advertised by the motor

manufacturer, with efficiency greater than the standard line. Motor efficiencies must have been verified in accordance with NEMA MG 1, 12.53.a., and determined using the dynamometer method as described in IEEE 112, Method B. All shop drawing submittals on motor driven equipment must include the motor efficiency.

2.8.3 Gear Pump (LP-1 and LP-2)

Lube oil transfer and receipt pumps must be rotary gear pumps. The pump construction must permit the removal of the gears without disconnecting the pump. Pump capacity must be 20 gal per minute with a differential pressure of 96 psi. The pump and motor must be mounted on a steel subbase. The motor must have sufficient power for the service required, be of a type approved by the manufacturer of the pump, be suitable for available electric service, be totally enclosed, fan cooled, TEFC, and conform to the requirements of Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Pump must be provided with stainless suction screen.

2.9 PACKAGED TRUCK OFFLOAD SYSTEM

The truck offload system must be a factory fabricated and skid mounted unit.

2.9.1 Offload Pump (OP)

Refer to paragraph OFFLOAD PUMP.

2.9.2 Air Eliminator Tank

2.9.2.1 Tank Housing

Each Tank housing must be fabricated from carbon steel and must be internally coated with an epoxy coating in accordance with MIL-PRF-4556. Coat the exterior with alkyd resin primer (universal metal primer). Each unit must be constructed and labeled in accordance with ASME BPVC SEC VIII D1. The housing must be designed for a working pressure of 90 psig. The inlet and outlet connections must be provided with raised face flanges faced and drilled in compliance with ASME B16.5, Class 150. Tank outlet must contain a anti-vortex plate. The configuration of the air eliminator tanks must be as shown on the drawings.

2.9.2.2 Sight Gauge

Provide a 5-inch armored, clear borosilicate (Pyrex) glass liquid level gauge for observing fuel level in the tank. The gauge must be equipped with stainless steel ball checks in both the upper and lower fittings, an upper and lower shutoff valve, and a bottom blowoff cock. The gauge will contain a colored density sensitive ball. Glass must be protected by a minimum of four guard rods.

2.9.2.3 High Level Shutoff

The vent connection must have a stainless steel high level shutoff mechanism to act as an overfill prevention device to keep fuel from going out the vent.

2.9.2.4 Level Sensors

The level sensors must be ultrasonic tip sensitive level control switches,

NEMA 7/9, weatherproof, explosion proof for Class I, Div I, Group D, temperature T2D (419 degrees F), 120-volt input power, SPST relay output, one-inch flanged mounting.

2.9.2.5 Vent

Tank vent outlet must be equipped with pressure-vacuum breather vent, aluminum construction with weather hood and with fluoroelastomer pallet seat inserts, high density screens, stainless steel internals, with pressure relief setting at 0.5 oz per square inch, and vacuum relief set at 32 oz per square inch. Pressure venting capacity must be 5400 cubic feet per hour, vacuum capacity must be 5000 cubic feet per hour.

2.9.3 Non-Surge Check/Air Block Valve

Refer to Section 33 52 43.14 AVIATION FUEL CONTROL VALVES.

2.9.4 Offload Fuel Hose

The offload fuel hose must be 4-inch, lightweight, flexible, minimum 8-inch bend radius, non-pressurized offloading hose constructed of nitrile rubber, rigid PVC helix, synthetic braiding, smooth bore, corrugated outer diameter, non-collapsible, threaded, male NPT, both ends, and have UV protection.

2.9.5 Offload Sight Flow Indicator

The Truck Offload sight flow indicator must be 4-inch wafer pattern sight glass, plane indicator aluminum construction.

2.9.6 Flowmeter

Meter must be positive displacement type as indicated in paragraph METERS, designed for a continuous flow of 300 GPM.

2.9.7 Grounding

The skid must be equipped with a self winding grounding cable reel. The cable must be at least 50 feet long. The cable reel, the grounding cable and the connection clamp must be in accordance with CID A-A-50696.

2.9.8 Grounding Verification Unit

System must include grounding plug, grounding cable, and monitoring and control module. System must automatically and continually monitor and verify a low-resistance static dissipation path (less than 10 Ohms) between connecting tanker and the designated ground point. Grounding plug must conform to MIL-DTL-83413 and MIL-DTL-83413/4 . Grounding cable must be corrosion resistant steel strands sheathed in a Hytrel jacket. Cable must be the spiral, self-retracting type. Cable must be a minimum 30 feet in length. Monitoring and control module must be rated for an explosion-proof environment in accordance with NFPA 70 for Class I, Division I, Group D locations. Module must include status lights (red for no ground verification and green for positive ground verification) and a lockable bypass switch. Module must include a switch contact to allow interlock functions.

2.9.9 Other Offload System Components

For other system components shown on the drawings as part of the offload system, refer to this Section and refer to this Section.

2.10 NOZZLES AND ADAPTERS

2.10.1 Nozzle Adapter (SPR)

Adapter must be a nominal 2-1/2-inches with self-closing valve in accordance with MIL-A-25896. Adapter must have a 4-inch flange mounting and vacuum tight, locking dust cap using the SPR lugs.

2.10.2 Quick Disconnect Coupler

Coupler must be the quick disconnect, cam type that conforms to CID A-A-59326.

2.10.3 Lube Oil Dispenser

Provide a ground-mounted hose reel with a hose length of at least 30 ft for each generator. The hose must be compatible with lube oil and meet the pump pressure requirements. Each hose supply side must be connected to the flanged side of the lube oil supply ball valves next to each generator. Provide a handheld dispensing nozzle with built-in meter and connect it to the dispensing side of the hose . Meter must be rated for a minimum flowrate of 8 gpm. The dispenser must be compatible with lube oil and be equipped with a non-drip nozzle.

2.11 FILTER/SEPARATOR

Provide filter/separator as specified in Section 33 52 43.28 FILTER SEPARATOR, AVIATION FUELING SYSTEM.

2.12 HIGH POINT VENT AND LOW POINT DRAIN PITS

2.12.1 Pit Assembly

Each pit must incorporate the following items built into a self-contained assembly.

2.12.2 Pit

The basic pit must consist of 0.25-inch wall fiberglass liner with a main body approximately 36-inches in diameter and a minimum of 37-inches deep. The pit must contain two integral concrete anchors. The fiberglass top flange must require no exposed corrosive material, weldments, or strongbacks within the pit to support the cast aluminum ring and cover assembly. The pits must be the standard products of a firm regularly engaged in the manufacture of such product and must essentially duplicate items that have been in satisfactory use for at least three years prior to bid opening. Proof of experience will be submitted.

2.12.3 Pit Cover, General Requirements

The pit cover must include a removable outer ring frame and an interior 18-inch diameter (clear opening) hinged lid that opens 160 degrees. The pit must have a tamperproof cover. The removable outer ring must have anchors to provide for means to secure the manhole and its moveable cover

and lid to the "concrete" fiberglass containment. The inner hinged lid must have a means of being locked. Each cover lid must move smoothly through its entire range of motion and must require a maximum opening force of 35 pound-force to be applied at a single lifting handle. Each handle must provide a comfortable, secure grip for an average adult male's full gloved hand. Tools must not be required to engage the lifting handle. Projections of the lid's hinges or handles above the plane of the lid, whether temporary or permanent, must not be allowed. The pit service must be integrally cast in raised letters on the top surface of each lid. The lettering must be a minimum of one-inch high and 0.0625-inch deep. The weight bearing flanges of the fiberglass pit liner and the aluminum cover frame (and lid) must be machined to assure uniform weight distribution.

2.12.4 Pit Cover Materials, Design, and Testing

The cover frames and lids must be designed and manufactured by a qualified company having a minimum of five years successful experience in the production of similar airport apron slab fixtures. All cover lids and frames must be designed using an appropriate cast aluminum alloy or rolled aluminum plate to support an aircraft wheel load simulated by a roving 200,000-pound test-load applied perpendicular to a 200-square-inch contact area(10 by 20 inches) of the cover's top surface. The aluminum alloy material selected for design must be ductile, corrosion-resistant, impact-resistant, and suitable for the intended use. All covers must be non-skid surface construction and free of injurious defects. Welding for the purpose of structural repair of casting defects must not be allowed. Minor cosmetic welding is acceptable. The cover must be capable of supporting the test-load without failure regardless of the location or orientation of the load. Localized yielding or cracking or excessive deformations must be considered as failure. Actual load-tests must be performed on a minimum of 10 percent of all the covers supplied. Load-tested units must be randomly selected. Load-test conditions must model field-installed conditions as nearly as practicable. The 200 Kip test-load must be applied to the cover for a minimum duration of 5-minutes. Absolute maximum deflection of the cover lid under the test-load must not exceed 1/180th of the interior diameter of the fiberglass pit body. Maximum deflection of the cover lids, remaining after removal of the test load must be plus 0.010-inches to assure that no permanent set has taken place. Upon removal of the test-load, the cover lid and frame must be carefully examined for cracks or localized areas of permanent deformation. All results must be submitted for review and approval. A single failure to meet any of the stated criteria must be considered sufficient grounds for the testing of 50 percent of the units.

2.12.5 Pipe Riser Seal

The riser pipe penetration through the pit floor must be sealed by means of a Buna-N boot. The boot must be secured to a metal collar welded to the pipe riser and to a flange at the floor opening by stainless steel clamps. Collar must be fabricated from the same material as the pipe.

2.13 FRP CONTAINMENT SUMP

Sump must be constructed of fiberglass reinforced plastic (FRP) that is chemically compatible with the fuels to be handled. Do not connect sump in any way to the manway cover or concrete above. Cap the top of each containment sump with a watertight access cover. Construct cover of the same material as the sump.

a. Rainfall drainage must not drain into a sump. Sump must be capable of withstanding underground burial loads to be encountered. Container must have a minimum 5 gal fuel storage capacity. Container must not contain any type of drain.

b. The sides of a containment sump must allow the penetration of carrier pipes, exterior containment pipes, conduits, and vapor pipes as required. Boot or seal penetrations in the containment sump sides to ensure that liquid will not escape from the sump in the event that the liquid level within the sump rises above the pipe penetration. Provide boots and seals that are chemically compatible with the fuel to be handled and that are water resistant to the influx of ground water. Boots and seals must be designed and installed to accommodate the anticipated amount of thermal expansion and contraction in the piping system.

2.14 LIQUID LEVEL GAUGE

Gauge must be the factory fabricated, sight glass assembly type designed to allow visual observation of liquid levels within a vessel. Assembly must include a 1/2-inch fully shielded glass tube, a ball check in both the upper and lower fittings, a shutoff valve in both the upper and lower fittings, guard rods, and a blowoff cock in the lower fitting. Gauge's body must be constructed of stainless steel.

2.15 OPERATING TANK LEVEL SWITCHES

a. System must be designed and installed in such a way that the system must be continuously and automatically self-checking. Switches must be mounted on top of the tank as indicated. Electronic level sensors must be thermistors or optic type, and be intrinsically safe Class I, Division 1, Group D for hazardous environments, with recognized FM, CSA or UL approval. The sensor holder/junction box must be accessible.

b. Level alarms must be mechanically and electrically independent and be totally isolated from the gauging system. The level switches must receive power and send their signal to the Pump Control Panel. Circuitry and cables from the PCP to the electronic level sensors in the tank must be intrinsically safe.

2.16 EMERGENCY EYEWASH

Provide self-contained emergency eyewash unit certified to ANSI Z358.1. The eyewash tank must be sized to meet a mimnimum of 0.4 gpm over a 15-minute period. The unit must include a 120-VAC heater to maintain a temperature of at least 68-degF. The unit shall include two bottles of manufacturer's water additives and the manufacturer's standard cleaning brush. The unit must have a mounting bracket. Mount the emergency eyewash unit to the filter shelter electrical equipment riser. Provide a voltage sensing circit that sends a discrete signal to the PCP indicating an EMERGENCY EYEWASH HEAT FAILURE.

2.17 GROUNDING CABLE AND CLAMP

Grounding system must conform to CID A-A-50696, Type I .

PART 3 EXECUTION

3.1 GENERAL

3.1.1 Installation

Install equipment and components in position, true to line, level and plumb, and measured from established benchmarks or reference points. Follow manufacturer's recommended practices for system components installation. Provide required clearances between equipment components, system components, apparatus, and accessories requiring normal servicing or maintenance to be accessible.

3.1.2 Anchoring

Anchor system components in place. Check alignment of anchor bolts before installing system components and clean-out associated sleeves. Do not cut bolts because of misalignment. Notify Contracting Officer of errors and obtain the Contracting Officer's acceptance before proceeding with corrections. Cut anchor bolts of excess length to the appropriate length without damage to threads. Where anchor bolts or like devices have not been installed, provide appropriate self-drilling type anchors for construction condition.

3.1.3 Grouting

System components which are anchored to a pad is to be grouted in place. Before setting system components in place and before placing grout, clean surfaces to be in contact with grout, including fasteners and sleeves. Remove standing water, debris, oil, rust, and coatings which impair bond. Clean contaminated concrete by grinding. Clean metal surfaces of mill scale and rust by hand or power tool methods. Provide necessary formwork for placing and retaining grout. Grout to be non-metallic, non-shrink, fluid precision grout of a hydraulic cementitious system with graded and processed silica aggregate, Portland cement, shrinkage compensating agents, plasticizing and water reducing agents; free of aluminum powder agents, oxidizing agents and inorganic accelerators, including chlorides; proportioned, pre-mixed and packaged at factory with only the addition of water required at the project site. Grouting must be in accordance with ASTM C827/C827M. Perform all grouting in accordance with system components manufacturer's and grout manufacturer's published specifications and recommendations.

3.1.4 Leveling and Aligning

Level and align system components in accordance with respective manufacturer's published data. Do not use anchor bolt, jack-nuts or wedges to support, level or align system components. Install only flat shims for leveling system components. Place shims to fully support system components. Wedging is not permitted. Shims to be fabricated flat carbon steel units of surface configuration and area not less than system components bearing surface. Shims to provide for full system components support. Shim to have smooth surfaces and edges, free from burrs and slivers. Flame or electrode cut edges not acceptable.

3.1.5 Direct Drives

Alignment procedure follows:

3.1.5.1 Rotation Direction and Speed

Check and correct drive shaft rotation direction and speed.

3.1.5.2 End Play

Run drive shafts at operational speed. Determine whether axial end play exists. Run drive shaft at operational speed and mark drive shaft axial position when end play exists. Block drive shaft in operating position when aligning drive shaft with driven shaft.

3.1.5.3 Shaft Leveling and Radial Alignment

Pump alignment must be accomplished by the factory technician or a millwright trained in pump alignment, and with the use of dial gauges or laser alignment equipment.

3.1.5.4 Angular Alignment and End Clearance

Check angular alignment and end clearance by inserting a feeler gage at 4 points, 90 degrees apart around outer edges of coupling halves.

3.1.5.5 Final Recheck

Check adjustments with dial indicator after completing recheck. Align shafts within 0.001-inch tolerance, except as other-wise required by more stringent requirements of system components manufacturer.

3.1.6 Precautions

Special care must be taken to ensure that system components and materials are stored properly to prevent damage and maintain cleanliness, and that the completed system is free of rocks, sand, dirt, and foreign objects. Take the following steps to insure these conditions.

a. System components brought to the site and not stored inside, must be stored on blocks or horses at least 18-inches above ground.

b. Visual inspection must be made of each piece of system components to ensure that it is clean prior to installation.

c. The open ends of system components must be closed when work with that piece of system components is not in progress.

3.2 INSTALLATION OF UNDERGROUND TANKS

Installation must be per tank manufacturer's recommendations, API RP 1615, NFPA 30, 40 CFR 280, state and local codes and as specified herein. If recommendations require tank to be filled, only fuel will be allowed in tanks. Water filling is not acceptable. Before being placed in service, tank must be tightness tested in accordance with NFPA 30.

3.3 INSTALLATION OF FIBERGLASS PITS

Submit recommended installation procedures and setting tolerances from the pit manufacturer/supplier for the fiberglass pit and the aluminum cover. These procedures must indicate recommended methods of supporting the pit in its proper position in the open excavation prior to and during concrete placement operations. Also, required installation tolerances, especially

for flatness/levelness of the fiberglass pit lip, must be provided. Follow these recommendations and apply other procedures as required to ensure the integrity of the pit liner and cover assemblies in their installed positions. All penetrations through the fiberglass pit liner must be tightly sealed by suitable means to preclude water infiltration, with consideration for potential relative movements between the penetrating objects and the pit liner. Reference the Contract drawings for additional installation requirements.

3.4 POSTED OPERATING INSTRUCTIONS

For each designated system or system components item, provide instructions for guidance of operating and maintenance personnel. Following approval of content, prepare these instructions in a form and scale that will be readily legible when displayed in appropriate locations, to be designated by the Contracting Officer and meet the following requirements:

3.4.1 Each System

For each system, include diagrams of system components, piping, wiring and control. Define control sequences.

3.4.2 Each Tank

For each tank provide a P.E. stamped certified tank calibration chart in 1/16-inch increments reading in gallons, except for tanks less than 5,000 gallons.

3.4.3 Each Item

For each system components item, include starting, adjustment, operation, lubrication, safety precautions and shut-down procedures. Identify procedures to be performed in event of system components failure. Provide other instructions recommended by the manufacturer.

3.4.4 Diagrams

Provide a professionally prepared isometric piping diagram of the fueling system apparatus. Diagram must be 36 by 54 inches and must be color coded to match PCP color diagrams. Diagram must show the entire facility and must include all system components and the operational sequences of all system components with equipment numbers displayed. Diagram must show all valves along with the valve numbers shown on the drawings and listed as normally open/closed. It must be wall mounted under glass.

3.4.5 Volume of Fuel

Provide a certified system inventory of fuel in the pipe, tank, etc. The piping will show length of pipe, size of pipe, gal/foot, and total gal. Verify during initial fill.

3.5 DEMONSTRATIONS

Conduct a training session for designated Government personnel in the operation and maintenance procedures related to the system components/systems specified herein. Include pertinent safety operational procedures in the session as well as physical demonstrations of the routine maintenance operations. Furnish instructors who are familiar with the installation/system components/systems, both operational and practical

theories, and associated routine maintenance procedures. The training session must consist of a total of 2 hours of normal working time and must start after the system is functionally completed, but prior to final system acceptance. Submit a letter, at least 14 working days prior to the proposed training date, scheduling a proposed date for conducting the on-site training.

-- End of Section --

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ATTACHMENTS:

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SECTION 33 71 02

UNDERGROUND ELECTRICAL DISTRIBUTION
08/21

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1.1 RELATED SECTIONS

Section 26 13 01 PAD-MOUNTED DEAD-FRONT AIR INSULATED SWITCHGEAR, applies to this section with the additions and modifications specified herin.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 318M	(2014; ERTA 2015) Building Code Requirements for Structural Concrete & Commentary

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8	(2013) Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B3	(2013; R 2024) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B800	(2005; R 2021) Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and

	Intermediate Tempers
ASTM B801	(2018) Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation
ASTM C32	(2013; R 2017) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C478	(2018) Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C857	(2016) Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM F2160	(2022a) Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 48	(2020) Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 386	(2016) Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV
IEEE 400.2	(2013) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
IEEE 404	(2012) Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V
IEEE C2	(2023) National Electrical Safety Code

IEEE C37.20.3	(2013) Standard for Metal-Enclosed Interrupter Switchgear
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-94-649	(2021) Concentric Neutral Cables Rated 5 Through 46 KV

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2021) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C119.1	(2023) Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts
NEMA C119.4	(2011) Electric Connectors - Connectors for Use Between Aluminum-to-Aluminum or Aluminum-to-Copper Conductors Designed for Normal Operation at or Below 93 Degrees C and Copper-to-Copper Conductors Designed for Normal Operation at or Below 100 Degrees C
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA TC 7	(2021) Smooth-Wall Coilable and Straight Electrical Polyethylene Conduit
NEMA TC 9	(2020) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation
NEMA WC 74/ICEA S-93-639	(2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

SOCIETY OF CABLE TELECOMMUNICATIONS ENGINEERS (SCTE)

ANSI/SCTE 77	(2013) Specification for Underground Enclosure Integrity

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-758	(2012b) Customer-Owned Outside Plant Telecommunications Infrastructure Standard

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS Bull 1751F-644	(2002) Underground Plant Construction

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-60005	(Basic; Notice 2) Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole

UL SOLUTIONS (UL)

UL 6	(2022) UL Standard for Safety Electrical Rigid Metal Conduit-Steel
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 94	(2023; Reprint May 2023) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint May 2021) UL Standard for Safety Wire Connectors
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2013; Reprint Jun 2022) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint May 2020) Conduit, Tubing and Cable Fittings
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 854	(2020; Reprint Jan 2022) Standard for Service-Entrance Cables
UL 1072	(2006; Reprint Apr 2020) Medium-Voltage Power Cables

UL 1242	(2006; Reprint Apr 2022) UL Standard for Safety Electrical Intermediate Metal Conduit -- Steel

1.3 SYSTEM DESCRIPTION

Items provided under this section must be specifically suitable for the following service conditions. Seismic details must conform to UFC 3-301-01, "Structural Engineering" and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 26 05 48 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

a. Altitude 5,663 feet.

1.4 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.5 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.

c. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Medium Voltage Cable; G, RO

Medium Voltage Cable Joints; G, RO

Medium Voltage Cable Terminations; G, RO

Precast Concrete Structures; G, DO

Sealing Material

Pulling-In Irons

Manhole Frames and Covers; G, DO

Handhole Frames and Covers; G, DOComposite/Fiberglass Handholes; G, DO

Cable Supports (racks, arms and insulators); G, RO

SD-06 Test Reports

Medium Voltage Cable Qualification and Production Tests; G, RO

Field Acceptance Checks and Tests; G, RO

Arc-proofing Test for cable fireproofing tape; G, RO

Cable Installation Plan and Procedure; G, RO

SD-07 Certificates

Cable splicer/terminator; G, RO

Cable Installer Qualifications; G, RO

Directional Boring Certificate of Conformance; G, RO

1.7 QUALITY ASSURANCE

1.7.1 Certificate of Competency for Cable Splicer/Terminator

1.7.2 Cable Installer Qualifications

Provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. Provide a resume showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers. Cable installer must demonstrate experience with a minimum of three medium voltage cable installations. The Contracting Officer reserves the right to require additional proof of competency or to reject the individual and call for an alternate qualified cable installer.

1.7.3 Directional Boring Certificate of Conformance

Provide certification of compliance with the registered Professional Engineer's design requirements for each directional bore, including: HDPE conduit size and type, bend radius, elevation changes, vertical and horizontal path deviations, conductor size and type and any conductor derating due to depth of conduit. Record location and depth of all directional-bore installed HDPE conduits using Global Positioning System (GPS) recording means with "resource grade" accuracy.

1.7.4 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of IEEE C2 and NFPA 70 unless more stringent requirements are specified or indicated.

1.7.5 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.7.5.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.7.5.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable, unless specified otherwise.

PART 2 PRODUCTS

2.1 CONDUIT, DUCTS, AND FITTINGS

Medium voltage cabling shall be direct buried unless otherwise indicated. Low voltage cabling shall be installed in conduit.

2.1.1 Rigid Metal Conduit

UL 6.

2.1.1.1 Rigid Metallic Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 400 volts per mil at 60 Hz, and tensile strength must be minimum 3500 psi.

2.1.2 Intermediate Metal Conduit

UL 1242.

2.1.2.1 Intermediate Metal Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 400 volts per mil at 60 Hz, and tensile strength must be minimum 3500 psi.

2.1.3 Plastic Conduit for Direct Burial and Riser Applications

UL 651 and NEMA TC 2, EPC-40 or EPC-80 as indicated.

2.1.4 Plastic Duct for Concrete Encasement

Provide Type EPC-40 per UL 651 and NEMA TC 2.

2.1.5 High Density Polyethylene (HDPE) Electrical Conduit for Directional Boring

Smoothwall, approved/listed for directional boring, minimum Schedule 80, ASTM F2160, NEMA TC 7.

2.1.6 Duct Sealant

UL 94, Class HBF. Provide high-expansion urethane foam duct sealant that expands and hardens to form a closed, chemically and water resistant, rigid structure. Sealant must be compatible with common cable and wire jackets and capable of adhering to metals, plastics and concrete. Sealant must be capable of curing in temperature ranges of 35 degrees F to 95 degrees F. Cured sealant must withstand temperature ranges of -20 degrees F to 200 degrees F without loss of function.

2.1.7 Fittings

2.1.7.1 Metal Fittings

UL 514B.

2.1.7.2 PVC Conduit Fittings

NEMA TC 3.

2.1.7.3 PVC Duct Fittings

NEMA TC 9.

2.1.7.4 Outlet Boxes for Steel Conduit

Outlet boxes for use with rigid or flexible steel conduit must be cast-metal cadmium or zinc-coated if of ferrous metal with gasketed closures and must conform to UL 514A.

2.2 LOW VOLTAGE INSULATED CONDUCTORS AND CABLES

Insulated conductors must be rated 600 volts and conform to the requirements of NFPA 70, including listing requirements. Wires and cables manufactured more than 24 months prior to date of delivery to the site are not acceptable. Service entrance conductors must conform to UL 854, type USE.

2.2.1 Conductor Types

Cable and duct sizes indicated are for copper conductors and THHN/THWN unless otherwise noted. Conductors No. 10 AWG and smaller must be solid. Conductors No. 8 AWG and larger must be stranded. All conductors must be copper.

2.2.2 Conductor Material

Unless specified or indicated otherwise or required by NFPA 70, wires in conduit, other than service entrance, must be 600-volt, Type THWN/THHN

conforming to UL 83. Copper conductors must be annealed copper complying with ASTM B3 and ASTM B8.

2.2.3 Jackets

Provide multiconductor cables with an overall PVC outer jacket.

2.2.4 Cable Marking

Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout the cable length.

Identify each cable by means of a fiber, laminated plastic, or non-ferrous metal tags in each manhole, handhole, junction box, and each terminal. Each tag must contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

Color code conductors. Provide conductor identification within each enclosure where a tap, splice, or termination is made. Conductor identification must be by color-coded insulated conductors, plastic-coated self-sticking printed markers, colored nylon cable ties and plates, heat shrink type sleeves,or colored electrical tape. Properly identify control circuit terminations. Color must be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals may be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems are as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

c. 120/240 volt, single phase: Black and red

d. On three-phase, four-wire delta system, high leg must be orange, as required by NFPA 70.

2.3 LOW VOLTAGE WIRE CONNECTORS AND TERMINALS

Provide a uniform compression over the entire conductor contact surface. Use solderless terminal lugs on stranded conductors.

a. For use with copper conductors: UL 486A-486B.

b. For use with aluminum conductors: UL 486A-486B. For connecting

aluminum to copper, connectors must be the circumferentially compressed, metallurgically bonded type.

2.4 LOW VOLTAGE SPLICES

Provide splices in conductors with a compression connector on the conductor and by insulating and waterproofing using one of the following methods which are suitable for continuous submersion in water and comply with ANSI C119.1.

2.4.1 Heat Shrinkable Splice

Provide heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material applied in accordance with the manufacturer's written instructions.

2.4.2 Cold Shrink Rubber Splice

Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation must not require heat or flame, or any additional materials such as covering or adhesive. It must be designed for use with inline compression type connectors, or indoor, outdoor, direct-burial or submerged locations.

2.5 MEDIUM VOLTAGE CABLE

Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length. Wires and cables manufactured more than 24 months prior to date of delivery to the site are not acceptable. Provide single conductor type cables unless otherwise indicated.

2.5.1 Cable Configuration

Provide Type MV cable, conforming to NEMA WC 74/ICEA S-93-639 and UL 1072 with concentric neutral underground distribution cable conforming to ICEA S-94-649. Provide cables manufactured for use in duct applications. Cable must be rated 15 kV with 133 percent insulation level.

2.5.2 Conductor Material

Provide concentric-lay-stranded, Class B compact round conductors. Provide aluminum alloy Type AA-8000 aluminum conductors complying with ASTM B800 and ASTM B801.

2.5.3 Shielding

Cables rated for 2 kV and above must have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape shield for each phase.

2.5.4 Neutrals

Neutral conductors must be aluminum, employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation

rating is acceptable.

2.5.5 Jackets

Provide cables with a PVC jacket. Direct buried cables must be rated for direct burial.

2.6 MEDIUM VOLTAGE CABLE TERMINATIONS

IEEE 48 Class 1; of the molded elastomer, prestretched elastomer, or heat-shrinkable elastomer. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Provide terminations, where required, with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, or armor. Provide terminations in a kit, including: skirts, stress control terminator, ground clamp, connectors, lugs, and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

2.6.1 Cold-Shrink Type

Terminator must be a one-piece design, utilizing the manufacturer's latest technology, where high-dielectric constant (capacitive) stress control is integrated within a skirted insulator made of silicone rubber. Termination must not require heat or flame for installation. Termination kit must contain all necessary materials (except for the lugs). Design termination for installation in low or highly contaminated indoor and outdoor locations and must resist ultraviolet rays and oxidative decomposition.

2.6.2 Heat Shrinkable Type

Terminator must consist of a uniform cross section heat shrinkable polymeric construction stress relief tubing and environmentally sealed outer covering that is nontracking, resists heavy atmospheric contaminants, ultra violet rays and oxidative decomposition. Provide heat shrinkable sheds or skirts of the same material. Design termination for installation in low or highly contaminated indoor or outdoor locations.

2.7 MEDIUM VOLTAGE CABLE JOINTS

Provide joints (splices) in accordance with IEEE 404 suitable for the rated voltage, insulation level, insulation type, and construction of the cable. Joints must be certified by the manufacturer for waterproof, submersible applications. Upon request, supply manufacturer's design qualification test report in accordance with IEEE 404. Connectors for joint must be tin-plated electrolytic copper, having ends tapered and having center stops to equalize cable insertion.

2.7.1 Heat-Shrinkable Joint

Consists of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating

material, and an integrally bonded outer conductor layer for shielding. Replace original cable jacket with a heavy-wall heat-shrinkable sleeve with hot-melt adhesive coating.

2.7.2 Cold-Shrink Rubber-Type Joint

Joint must be of a cold shrink design that does not require any heat source for its installation. Splice insulation and jacket must be of a one-piece factory formed cold shrink sleeve made of black EPDM rubber. Splice should be packaged three splices per kit, including complete installation instructions.

2.8 TAPE

2.8.1 Insulating Tape

UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

2.8.2 Buried Warning and Identification Tape

Provide detectable tape in accordance with Section 31 00 00 EARTHWORK.

2.8.3 Fireproofing Tape

Provide tape composed of a flexible, conformable, unsupported intumescent elastomer. Tape must be not less than .030 inch thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, adhesive-free, and must not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

2.9 PULL ROPE

Plastic or flat pull line (bull line) having a minimum tensile strength of 200 pounds.

2.10 GROUNDING AND BONDING

2.10.1 Driven Ground Rods

Provide copper-clad steel ground rods conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used for rods 20 feet or longer.

2.10.2 Grounding Conductors

Stranded-bare copper conductors must conform to ASTM B8, Class B, soft-drawn unless otherwise indicated. Solid-bare copper conductors must conform to ASTM B1 for sizes No. 8 and smaller. Insulated conductors must be of the same material as phase conductors and green color-coded, except that conductors must be rated no more than 600 volts. Aluminum is not acceptable.

2.11 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. In addition, provide concrete for encasement of underground ducts with 3000 psi minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground

ducts must be 4000 psi minimum 28-day compressive strength unless specified otherwise.

2.12 UNDERGROUND STRUCTURES

Provide precast concrete underground structures or standard type cast-in-place manhole types as indicated, conforming to ASTM C857 and ASTM C478. Top, walls, and bottom must consist of reinforced concrete. Walls and bottom must be of monolithic concrete construction. Locate duct entrances and windows near the corners of structures to facilitate cable racking. Covers must fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Install a pulling-in iron in the wall opposite each duct line entrance. Cable racks, including rack arms and insulators, must be adequate to accommodate the cable.

2.12.1 Cast-In-Place Concrete Structures

Concrete must conform to Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.12.2 Precast Concrete Structures, Risers and Tops

Precast concrete underground structures may be provided in lieu of cast-in-place subject to the requirements specified below. Precast units must be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes.

2.12.2.1 General

Precast concrete structures must have the same accessories and facilities as required for cast-in-place structures. Likewise, precast structures must have plan area and clear heights not less than those of cast-in-place structures. Concrete materials and methods of construction must be the same as for cast-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work must have a 28-day compressive strength of not less than 4000 psi. Structures may be precast to the design and details indicated for cast-in-place construction, precast monolithically and placed as a unit, or structures may be assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. Structures must be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.

2.12.2.2 Design for Precast Structures

ACI 318M. In the absence of detailed on-site soil information, design for the following soil parameters/site conditions:

a. Angle of Internal Friction (phi) = 30 degrees

b. Unit Weight of Soil (Dry) = 110 pcf, (Saturated) = 130 pcf

c. Coefficient of Lateral Earth Pressure (Ka) = 0.33

d. Ground Water Level = 3 feet below ground elevation

e. Vertical design loads must include full dead, superimposed dead, and live loads including a 30 percent magnification factor for impact. Live loads must consider all types and magnitudes of vehicular (automotive, industrial, or aircraft) traffic to be encountered. The minimum design vertical load must be for H20 highway loading per AASHTO HB-17.

f. Horizontal design loads must include full geostatic and hydrostatic pressures for the soil parameters, water table, and depth of installation to be encountered. Also, horizontal loads imposed by adjacent structure foundations, and horizontal load components of vertical design loads, including impact, must be considered, along with a pulling-in iron design load of 6000 pounds.

g. Each structural component must be designed for the load combination and positioning resulting in the maximum shear and moment for that particular component.

h. Design must also consider the live loads induced in the handling, installation, and backfilling of the manholes. Provide lifting devices to ensure structural integrity during handling and installation.

2.12.2.3 Construction

Provide a uniform thickness for structure top, bottom, and wall not less than 6 inches. Thin-walled knock-out panels for designed or future duct bank entrances are not permitted. Provide quantity, size, and location of duct bank entrance windows as directed, and cast completely open by the precaster. Size of windows must exceed the nominal duct bank envelope dimensions by at least 12 inches vertically and horizontally to preclude in-field window modifications made necessary by duct bank misalignment. However, the sides of precast windows must be a minimum of 6 inches from the inside surface of adjacent walls, floors, or ceilings. Form the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope. Provide welded wire fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes. Provide additional reinforcing steel comprised of at least two No. 4 bars around window openings. Provide drain sumps a minimum of 12 inches in diameter and 4 inches deep for precast structures.

2.12.2.4 Joints

Provide tongue-and-groove joints on mating edges of precast components. Shiplap joints are not allowed. Design joints to firmly interlock adjoining components and to provide waterproof junctions and adequate shear transfer. Seal joints watertight using preformed plastic strip conforming to ASTM C990. Install sealing material in strict accordance with the sealant manufacturer's printed instructions. Provide waterproofing at conduit/duct entrances into structures, and where access frame meets the top slab, provide continuous grout seal.

2.12.3 Manhole Frames and Covers

Provide cast iron frames and covers for manholes conforming to CID A-A-60005. Cast the words "ELECTRIC" or "TELECOMMUNICATIONS" in the

top face of power and telecommunications manhole covers, respectively.

2.12.4 Handhole Frames and Covers

Frames and covers of steel must be welded by qualified welders in accordance with standard commercial practice. Provide rolled-steel floor plate covers having an approved antislip surface. Hinges must be of stainless steel with bronze hinge pin , 5 by 5 inches by approximately 3/16 inch thick, without screw holes, and must be for full surface application by fillet welding. Hinges must have nonremovable pins and five knuckles. The surfaces of plates under hinges must be true after the removal of raised antislip surface, by grinding or other approved method.

2.12.5 Brick for Manhole Collar

Provide sewer and manhole brick conforming to ASTM C32, Grade MS.

2.12.6 Composite/Fiberglass Handholes and Covers

ANSI/SCTE 77. Provide handholes and covers of polymer concrete, reinforced with heavy weave fiberglass with a design load (Tier rating) appropriate for or greater than the intended use. All covers are required to have the Tier level rating embossed on the surface which must not exceed the design load of the box.

2.13 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

Zinc coat the metal portion of racks and arms after fabrication.

2.13.1 Cable Rack Stanchions

The wall bracket or stanchion must be 4 inches by approximately 1-1/2 inch by 3/16 inch channel steel, or 4 inches by approximately 1 inch glass-reinforced nylon with recessed bolt mounting holes, 48 inches long (minimum) in manholes. Space slots for mounting cable rack arms at 8 inch intervals.

2.13.2 Rack Arms

Cable rack arms must be steel or malleable iron or glass reinforced nylon and must be of the removable type. Rack arm length must be a minimum of 8 inches and a maximum of 12 inches.

2.13.3 Insulators

Insulators for metal rack arms must be dry-process glazed porcelain. Insulators are not required for nylon arms.

2.14 CABLE TAGS IN MANHOLES

Provide polyethylene tags for each power cable located in manholes. Do not provide handwritten letters. The first position on the power cable tag denotes the voltage. The second through sixth positions on the tag identifies the circuit. The next to last position denotes the phase of the circuit and include the Greek "phi" symbol. The last position denotes the cable size. As an example, a tag could have the following designation: "11.5 NAS 1-8(Phase A)500," denoting that the tagged cable is on the 11.5kV system circuit number NAS 1-8, underground, Phase A, sized at 500 kcmil.

2.14.1 Polyethylene Cable Tags

Provide tags of polyethylene having an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag, having a minimum loop tensile strength of 175 pounds and black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols must not fall off or change positions regardless of the cable tags' orientation.

2.15 MEDIUM VOLTAGE ABOVE GROUND CABLE TERMINATING CABINETS

Cable terminating cabinets must be hook-stick operable, deadfront construction conforming to the requirements of IEEE C37.20.3, Category A. Provide cabinets with 600 A. dead-break junctions and elbow-type separable dead-break connectors, cable parking stands, and grounding lugs. Provide cable terminating equipment in conformance with IEEE 386.

Ratings at 60 Hz must be:

Nominal voltage (kV)	13.2
Rated maximum voltage (kV)	15
Rated continuous current (A)	600
One-second short-time current-carrying capacity (kA)	12.5
BIL (kV)	95

2.16 LOW VOLTAGE ABOVE GROUND TERMINATION PEDESTAL

Provide copolymer polypropylene, low voltage above ground termination pedestal manufactured through an injection molding process. Pedestals must resist fertilizers, salt air environments and ultra-violet radiation. Pedestal top must be imprinted with a "WARNING" and "ELECTRIC" identification. Pedestal must contain lay-in six port connectors, NEMA C119.4, Class "A", dual rated for aluminum or copper, and capable of terminating conductors ranging from 10 AWG to 500 kcmil. Protect each connector with a clear, hard lexan (plastic) cover. Provide pedestal with rust-free material and stainless steel hardware that is lockable.

2.17 SOURCE QUALITY CONTROL

2.17.1 Arc-Proofing Test for Cable Fireproofing Tape

Manufacturer must test one sample assembly consisting of a straight lead tube 12 inches long with a 2 1/2 inch outside diameter, and a 1/8 inch thick wall, and covered with one-half lap layer of arc and fireproofing tape per manufacturer's instructions. The arc and fireproofing tape must withstand extreme temperature of a high-current fault arc 13,000 degrees K for 70 cycles as determined by using an argon directed plasma jet capable of constantly producing and maintaining an arc temperature of 13,000 degrees K. Temperature (13,000 degrees K) of the ignited arc between the

cathode and anode must be obtained from a dc power source of 305 (plus or minus 5) amperes and 20 (plus or minus 1) volts. Direct the arc toward the sample assembly accurately positioned 5 (plus or minus 1) millimeters downstream in the plasma from the anode orifice by fixed flow rate of argon gas (0.18 g per second). Test each sample assembly at three unrelated points. Start time for tests must be taken from recorded peak current when the specimen is exposed to the full test temperature. Surface heat on the specimen prior to that time must be minimal. The end point is established when the plasma or conductive arc penetrates the protective tape and strikes the lead tube. Submittals for arc-proofing tape must indicate that the test has been performed and passed by the manufacturer.

2.17.2 Medium Voltage Cable Qualification and Production Tests

Results of AEIC CS8 qualification and production tests as applicable for each type of medium voltage cable.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable. In addition to these requirements, install telecommunications in accordance with TIA-758 and RUS Bull 1751F-644.

3.2 CABLE INSPECTION

Inspect each cable reel for correct storage positions, signs of physical damage, and broken end seals prior to installation. If end seal is broken, remove moisture from cable prior to installation in accordance with the cable manufacturer's recommendations.

3.3 CABLE INSTALLATION PLAN AND PROCEDURE

Obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature limits for installation, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, maximum allowable pulling tension, and maximum allowable sidewall bearing pressure. Perform pulling calculations and prepare a pulling plan and submit along with the manufacturer's instructions in accordance with SUBMITTALS. Install cable strictly in accordance with the cable manufacturer's recommendations and the approved installation plan.

Calculations and pulling plan must include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

e. Cable pulling tension calculations of all cable pulls.

f. Cable percentage conduit fill.

g. Cable sidewall bearing pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

3.4 UNDERGROUND FEEDERS SUPPLYING BUILDINGS

Terminate underground feeders supplying building at a point 5 feet outside the building and projections thereof, except that conductors must be continuous to the terminating point indicated. Coordinate connections of the feeders to the service entrance equipment with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide PVC, Type EPC-40 conduit from the supply equipment to a point 5 feet outside the building and projections thereof. Protect ends of underground conduit with plastic plugs until connections are made.

3.5 UNDERGROUND STRUCTURE CONSTRUCTION

Provide standard type cast-in-place construction as specified herein and as indicated, or precast construction as specified herein. Horizontal concrete surfaces of floors must have a smooth trowel finish. Cure concrete by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound must conform to ASTM C309. Locate duct entrances and windows in the center of end walls (shorter) and near the corners of sidewalls (longer) to facilitate cable racking and splicing. Covers for underground structures must fit the frames without undue play. Form steel and iron to shape and size with sharp lines and angles. Castings must be free from warp and blow holes that may impair strength or appearance. Exposed metal must have a smooth finish and sharp lines and arises. Provide necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. Manhole locations, as indicated, are approximate. Coordinate exact manhole locations with other utilities and finished grading and paving.

3.5.1 Cast-In-Place Concrete Structures

Construct walls on a footing of cast-in-place concrete except that precast concrete base sections may be used for precast concrete manhole risers.

3.5.2 Precast Concrete Construction

Set commercial precast structures on 6 inches of level, 90 percent compacted granular fill, 3/4 inch to 1 inch size, extending 12 inches beyond the structure on each side. Compact granular fill by a minimum of four passes with a plate type vibrator. Installation must additionally conform to the manufacturer's instructions.

3.5.3 Pulling-In Irons

Provide steel bars bent as indicated, and cast in the walls and floors. Alternatively, pipe sleeves may be precast into the walls and floors where required to accept U-bolts or other types of pulling-in devices possessing the strengths and clearances stated herein. The final installation of pulling-in devices must be made permanent. Cover and seal exterior projections of thru-wall type pulling-in devices with an appropriate protective coating. In the floor, locate the irons a minimum of 6 inches from the edge of the sump, and in the walls, locate the irons within 6 inches of the projected center of the duct bank pattern or precast window in the opposite wall. However, the pulling-in iron must not be located within 6 inches of an adjacent interior surface, or duct or precast window located within the same wall as the iron. If a pulling-in iron cannot be located directly opposite the corresponding duct bank or precast window due to this clearance limitation, locate the iron directly above or below the projected center of the duct bank pattern or precast window the minimum distance required to preserve the 6 inch clearance previously stated. In the case of directly opposing precast windows, pulling-in irons consisting of a 3 foot length of No. 5 reinforcing bar, formed into a hairpin, may be cast-in-place within the precast windows simultaneously with the end of the corresponding duct bank envelope. Irons installed in this manner must be positioned directly in line with, or when not possible, directly above or below the projected center of the duct bank pattern entering the opposite wall, while maintaining a minimum clear distance of 3 inches from any edge of the cast-in-place duct bank envelope or any individual duct. Pulling-in irons must have a clear projection into the structure of approximately 4 inches and must be designed to withstand a minimum pulling-in load of 6000 pounds. Hot-dip galvanize irons after fabrication.

3.5.4 Cable Racks, Arms and Insulators

Cable racks, arms and insulators must be sufficient to accommodate the cables. Space racks in power manholes not more than 3 feet apart, and provide each manhole wall with a minimum of two racks. Space racks in signal manholes not more than 16 1/2 inches apart with the end rack being no further than 12 inches from the adjacent wall. Methods of anchoring cable racks are as follows:

a. Provide a 5/8 inch diameter by 5 inch long anchor bolt with 3 inch foot cast in structure wall with 2 inch protrusion of threaded portion of bolt into structure. Provide 5/8 inch steel square head nut on each anchor bolt. Coat threads of anchor bolts with suitable coating immediately prior to installing nuts.

b. Provide concrete channel insert with a minimum load rating of 800 pounds per foot. Insert channel must be steel of the same length as "vertical rack channel;" and cast flush in structure wall. Provide 5/8 inch steel nuts in channel insert to receive 5/8 inch diameter by 3 inch long steel, square head anchor bolts.

c. Provide concrete "spot insert" at each anchor bolt location, cast flush in structure wall. Each insert must have minimum 800 pound load rating. Provide 5/8 inch diameter by 3 inch long steel, square head anchor bolt at each anchor point. Coat threads of anchor bolts with suitable coating immediately prior to installing bolts.

3.5.5 Field Painting

Clean cast-iron frames and covers not buried in concrete or masonry of mortar, rust, grease, dirt and other deleterious materials, and coat with bituminous paint.

3.6 UNDERGROUND CONDUIT AND DUCT SYSTEMS

3.6.1 Requirements

Run conduit in straight lines except where a change of direction is necessary. Provide numbers and sizes of ducts as indicated. Provide a 4/0 AWG bare copper grounding conductor above medium-voltage distribution duct banks. Bond bare copper grounding conductor to ground rings (loops) in all manholes and to ground rings (loops) at all equipment slabs (pads). Route grounding conductor into manholes with the duct bank (sleeving is not required). Ducts must have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Terminate all PVC conduit end points in utility holes, switching cabinets, transform handholes and buildings with end bells. The bell end of the conduits that enter manholes and handholes must be flush with the wall.

Perform changes in ductbank direction as follows:

a. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable.

b. The minimum manufactured bend radius must be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter.

c. As an exception to the bend radius required above, provide field manufactured longsweep bends having a minimum radius of 25 feet for a change of direction of more than 5 degrees, either horizontally or vertically, using a combination of curved and straight sections. Maximum manufactured curved sections allowed for use in field manufactured longsweep bend: 30 degrees.

3.6.2 Treatment

Keep ducts clean of concrete, dirt, or foreign substances during construction. Make field cuts requiring tapers with proper tools and match factory tapers. Use a coupling recommended by the duct manufacturer whenever an existing duct is connected to a duct of different material or shape. Store ducts to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Thoroughly clean ducts before being laid. Store plastic ducts on a flat surface and protected from the direct rays of the sun.

3.6.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install

conduit plugs. For conduit sizes less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

3.6.4 Jacking and Drilling Under Roads and Structures

Conduits to be installed under existing paved areas which are not to be disturbed, and under roads and railroad tracks, must be zinc-coated, rigid steel, jacked into place. Where ducts are jacked under existing pavement, install rigid steel conduit because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 50 feet in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks must be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers. Hydraulic jet method must not be used.

3.6.5 Galvanized Conduit Concrete Penetrations

Galvanized conduits which penetrate concrete (slabs, pavement, and walls) in wet locations must be PVC coated and extend from at least 2 inches within the concrete to the first coupling or fitting outside the concrete (minimum of 6 inches from penetration).

3.6.6 Multiple Conduits

Separate multiple conduits by a minimum distance of 3 inches, except that light and power conduits must be separated from control, signal, and telephone conduits by a minimum distance of 12inches (this seperation may be reduced to 3" when the ducts are concrete encased). Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly must consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 10 feet of conduit assembly.

3.6.7 Conduit Plugs and Pull Rope

Provide new conduit indicated as being unused or empty with plugs on each end. Plugs must contain a weephole or screen to allow water drainage. Provide a plastic pull rope having 3 feet of slack at each end of unused or empty conduits.

3.6.8 Conduit and Duct Without Concrete Encasement

Depths to top of the conduit must be not less than 24 inches below finished grade. Provide not less than 3 inches clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 1/4 inch sieve. The first 6 inch layer of backfill cover must be sand compacted as previously specified. The rest of the excavation must be backfilled and compacted in 3 to 6 inch layers. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

3.6.8.1 Encasement Under Roads and Structures

Under roads, paved areas, and railroad tracks, install conduits in concrete encasement of rectangular cross-section providing a minimum of 3 inch concrete cover around ducts. Extend concrete encasement at least 5 feet beyond the edges of paved areas and roads, and 12 feet beyond the rails on each side of railroad tracks. Depths to top of the concrete envelope must be not less than 24 inches below finished grade.

3.6.8.2 Directional Boring

HDPE conduits must be installed below the frostline and as specified herein.

For distribution voltages greater than 1000 volts and less than 34,500 volts, depths to the top of the conduit must not be less than 48 inches in pavement-covered areas and not less than 120 inches in non-pavement-covered areas.

3.6.9 Duct Encased in Concrete

Construct underground duct lines of individual conduits encased in concrete. Depths to top of the concrete envelope must be not less than 18 inches below finished grade, except under roads and pavement, concrete envelope must be not less than 24 inches below finished grade. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank must be rectangular in cross-section and provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 3 inches. Before pouring concrete, anchor duct bank assemblies, prevent floating during concrete pouring by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly.

3.6.9.1 Connections to Manholes

Duct bank envelopes connecting to underground structures must be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section must be larger than the corresponding manhole opening dimensions by no less than 12 inches in each direction. Perimeter of the duct bank opening in the underground structure must be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.

3.6.9.2 Connections to Existing Underground Structures

For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and extend into the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

3.6.9.3 Connections to Existing Concrete Pads

For duct bank connections to concrete pads, break an opening in the pad out to the dimensions required and preserve steel in pad. Cut the steel and extend into the duct bank envelope. Chip out the opening in the pad to form a key for the duct bank envelope.

3.6.9.4 Connections to Existing Ducts

Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks. Remove existing cables which constitute interference with the work. Abandon in place those no longer used ducts and cables which do not interfere with the work.

3.6.9.5 Partially Completed Duct Banks

During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately one foot apart. Restrain reinforcing assembly from moving during concrete pouring.

3.6.9.6 Removal of Ducts

Where duct lines are removed from existing underground structures, close the openings to waterproof the structure. Chip out the wall opening to provide a key for the new section of wall.

3.6.10 Duct Sealing

Seal all electrical penetrations for radon mitigation, maintaining integrity of the vapor barrier, and to prevent infiltration of air, insects, and vermin.

3.7 CABLE PULLING

Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures. Cable with tape shield must have a bending radius not less than 12 times the overall diameter of the completed cable. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

3.7.1 Cable Lubricants

Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

3.8 CABLES IN UNDERGROUND STRUCTURES

Do not install cables utilizing the shortest path between penetrations, but route along those walls providing the longest route and the maximum

spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space open for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure.

3.8.1 Cable Tag Installation

Install cable tags in each manhole as specified, including each splice. Tag wire and cable provided by this contract. Install cable tags over the fireproofing, if any, and locate the tags so that they are clearly visible without disturbing any cabling or wiring in the manholes.

3.9 CONDUCTORS INSTALLED IN PARALLEL

Group conductors such that each conduit of a parallel run contains one Phase A conductor, one Phase B conductor, one Phase C conductor, and one neutral conductor.

3.10 LOW VOLTAGE CABLE SPLICING AND TERMINATING

Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after the splicing material has completely set.3.11 MEDIUM VOLTAGE CABLE TERMINATIONS

Make terminations in accordance with the written instruction of the termination kit manufacturer.

3.12 MEDIUM VOLTAGE CABLE JOINTS

Provide power cable joints (splices) suitable for continuous immersion in water. Make joints only in accessible locations in manholes or handholes by using materials and methods in accordance with the written instructions of the joint kit manufacturer.

3.12.1 Joints in Armored Cables

Enclose armored cable joints in compound-filled, cast-iron or alloy splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

3.12.2 Joints in Shielded Cables

Cover the joined area with metallic tape, or material like the original cable shield and connect it to the cable shield on each side of the splice. Provide a bare copper ground connection brought out in a watertight manner and grounded to the manhole grounding loop as part of the splice installation. Ground conductors, connections, and rods must be as specified elsewhere in this section. Wire must be trained to the sides of the enclosure to prevent interference with the working area.

3.13 CABLE END CAPS

Cable ends must be sealed at all times with coated heat shrinkable end

caps. Cables ends must be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps must remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

3.14 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES

Fireproof (arc proof) wire and cables which will carry current at 2200 volts or more in underground structures.

3.14.1 Fireproofing Tape

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Install tape in accordance with manufacturer's instructions.

3.14.2 Tape-Wrap

Tape-wrap metallic-sheathed or metallic armored cables without a nonmetallic protective covering over the sheath or armor prior to application of fireproofing. Wrap must be in the form of two tightly applied half-lapped layers of a pressure-sensitive 10 mil thick plastic tape, and must extend not less than one inch into the duct. Even out irregularities of the cable, such as at splices, with insulation putty before applying tape.

3.15 GROUNDING SYSTEMS

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 10 ohms.

3.15.1 Grounding Electrodes

Provide cone pointed driven ground rods driven full depth plus 12 inches, installed to provide an earth ground of the appropriate value for the particular equipment being grounded.
If the specified ground resistance is not met, provide an additional ground rod in accordance with the requirements of NFPA 70 (placed not less than 6 feet from the first rod). Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, notify the Contracting Officer immediately.

3.15.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies must be as recommended by the manufacturer. An embossing die code or other standard method must provide visible indication that a connector has

been adequately compressed on the ground wire.

3.15.3 Grounding Conductors

Provide bare grounding conductors, except where installed in conduit with associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with No. 6 AWG. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

3.15.4 Ground Cable Crossing Expansion Joints

Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

3.15.5 Manhole Grounding

Loop a 4/0 AWG grounding conductor around the interior perimeter, approximately 12 inches above finished floor. Secure the conductor to the manhole walls at intervals not exceeding 36 inches. Connect the conductor to the manhole grounding electrode with 4/0 AWG conductor. Connect all incoming 4/0 grounding conductors to the ground loop adjacent to the point of entry into the manhole. Bond the ground loop to all cable shields, metal cable racks, and other metal equipment with a minimum 6 AWG conductor.

3.16 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70 and Section 31 00 00 EARTHWORK.

3.16.1 Reconditioning of Surfaces

3.16.1.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct . Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding, and provide topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

3.16.1.2 Paving Repairs

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists , restore such surface treatment or pavement the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.

3.17 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.17.1 Concrete Slabs (Pads) for Equipment

Unless otherwise indicated, the slab must be at least 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 4 inches from the top of the slab. Place slab on a 6 inch thick, well-compacted gravel base. Top of concrete slab must be approximately 4 inches above finished grade with gradual slope for drainage. Edges above grade must have 1/2 inch chamfer. Slab must be of adequate size to project at least 8 inches beyond the equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.17.2 Sealing

When the installation is complete, seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals must be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.18 FIELD QUALITY CONTROL

3.18.1 Performance of Field Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.18.1.1 Medium Voltage Cables

Perform tests after installation of cable, splices, and terminators and before terminating to equipment or splicing to existing circuits.

a. Visual and Mechanical Inspection

(1) Inspect exposed cable sections for physical damage.

(2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

(3) Inspect for proper shield grounding, cable support, and cable termination.

(4) Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.

(5) Inspect for proper fireproofing.

(6) Visually inspect jacket and insulation condition.

(7) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform a shield continuity test on each power cable by ohmmeter method. Record ohmic value, resistance values in excess of 10 ohms per 1000 feet of cable must be investigated and justified.

(2) Perform acceptance test on new cables before the new cables are connected to existing cables and placed into service, including terminations and joints. Perform maintenance test on complete cable system after the new cables are connected to existing cables and placed into service, including existing cable, terminations, and joints. Tests must be very low frequency (VLF) alternating voltage withstand tests in accordance with IEEE 400.2. VLF test frequency must be 0.05 Hz minimum for a duration of 60 minutes using a sinusoidal waveform. Test voltages must be as follows:

CABLE RATING AC TEST VOLTAGE for ACCEPTANCE TESTING	
5 kV	10kV rms(peak)
8 kV	13kV rms(peak)
15 kV	20kV rms(peak)
25 kV	31kV rms(peak)
35 kV	44kV rms(peak)

CABLE RATING AC TEST VOLTAGE for MAINTENANCE TESTING	
5 kV	7kV rms(peak)
8 kV	10kV rms(peak)
15 kV	16kV rms(peak)
25 kV	23kV rms(peak)
35 kV	33kV rms(peak)

3.18.1.2 Low Voltage Cables, 600-Volt

Perform tests after installation of cable, splices and terminations and before terminating to equipment or splicing to existing circuits.

a. Visual and Mechanical Inspection

(1) Inspect exposed cable sections for physical damage.

(2) Verify that cable is supplied and connected in accordance with contract plans and specifications.

(3) Verify tightness of accessible bolted electrical connections.

(4) Inspect compression-applied connectors for correct cable match and indentation.

(5) Visually inspect jacket and insulation condition.

(6) Inspect for proper phase identification and arrangement.

b. Electrical Tests

(1) Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 1000 volts dc for one minute.

(2) Perform continuity tests to insure correct cable connection.

3.18.1.3 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE 81. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance.

3.18.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer must be given 5 working days advance notice of the dates and times of checking and testing.

-- End of Section --

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BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
PROJECT #: CRWU203004

PROJECT AREA MAP

TRUE NORTH

ENLARGED PROJECT LOCATION MAP

SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD
ISSUE DATE: 07/03/2024

COLORADO LICENSED
KELTON MANNING
61114
7/3/2024
PROFESSIONAL ENGINEER

COLORADO LICENSED
KENT BLUMENT
26325
7/3/2024
PROFESSIONAL ENGINEER

SHEET INDEX

SHEET #	SHEET NAME	RTA
GENERAL		
GI001	COVER SHEET & SHEET INDEX	X
GI002	GENERAL NOTES, ABBREVIATIONS	X
CIVIL		
VF101	OVERALL EXISTING CONDITIONS	X
VF102	ENLARGED EXISTING CONDITIONS AREA 1	X
VF103	ENLARGED EXISTING CONDITIONS AREA 2	X
VF104	ENLARGED EXISTING CONDITIONS AREA 3	X
VF105	ENLARGED EXISTING CONDITIONS AREA 4	X
VF106	ENLARGED EXISTING CONDITIONS AREA 5	X
VF107	ENLARGED EXISTING CONDITIONS AREA 6	X
VF108	OVERALL BORING LOCATIONS	X
VF109	GEOTECHNICAL BORING LOGS	X
CI101	CONTRACTOR ACCESS AND STAGING	X
CS101	SITE RESTORATION PLAN	X
CG101	EROSION AND SEDIMENT CONTROL PLAN	X
CG201	ATO PAD GRADING PLAN	X
CU101	OVERALL UTILITY PLAN	X
CU102	PRIMARY CABLE ALIGNMENT PLAN AND PROFILE 1	X
CU103	PRIMARY CABLE ALIGNMENT PLAN AND PROFILE 2	X
CU104	REDUNDANT POWER FEED PLAN AND PROFILE 1	X
CU105	REDUNDANT POWER FEED PLAN AND PROFILE 2	X
CU106	REDUNDANT POWER FEED PLAN AND PROFILE 3	X
CU107	REDUNDANT POWER FEED PLAN AND PROFILE 4	X
ELECTRICAL		
E-001	ELECTRICAL ABBREVIATIONS	
E-002	ELECTRICAL LEGEND AND NOTES	
E-003	ELECTRICAL LEGEND AND NOTES	
ED101	ELECTRICAL DEMO OVERALL SITE PLAN	
ED401	ENLARGED ELECTRICAL DEMO SITE PLAN	
ED601	ELECTRICAL DEMO ONE-LINE	
ES101	ELECTRICAL OVERALL SITE PLAN	
ES401	ENLARGED ELECTRICAL SITE PLAN	
E-501	DUCTBANK AND BORING TRENCH DETAILS	
E-502	DOUBLE MANHOLE VAULT DETAILS	
E-503	TRIPLE MANHOLE VAULT DETAILS	
E-504	TRIPLE MANHOLE VAULT DETAILS CONT.	
E-505	TYPICAL DRAIN DETAILS	
E-506	6 WAY PAD MOUNTED SWITCHGEAR ONE-LINE	
E-507	STANDARD MANHOLE AND HANDHOLE DETAIL	
E-601	ELECTRICAL ONE-LINE	

Controlled by: USACE, Omaha District and USAF
CUI Category: General Critical Infrastructure, Defense, Export Control, OPSEC

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

DESIGNED BY: K. COUGHLIN
DRAWN BY: K. COUGHLIN
CHECKED BY: C. PETERSON
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D

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REDUNDANT ELECTRICAL SUPPLY
CRWU203004
COVER SHEET & SHEET INDEX

SHEET ID
GI001

READY-TO-ADVERTISE (RTA) SUBMITTAL

DRAWING ABBREVIATIONS

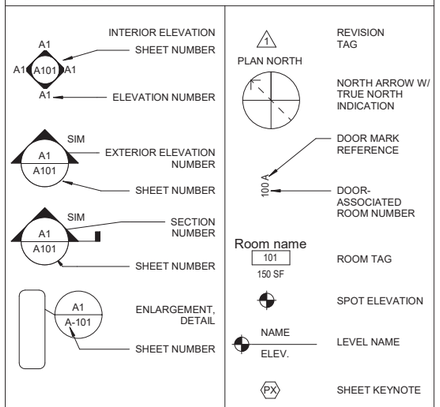
A	
A/C	AIR CONDITION
A/C UNIT	AIR CONDITIONING UNIT
A/E	ARCHITECT/ENGINEER
AB	ANCHOR BOLT
ACC	ACCESSIBLE
ACS	AUTOMATIC CONTROL SYSTEM
ACS DR	ACCESS DOOR
ACS PNL	ACCESS PANEL
ACT	ACOUSTICAL CEILING TILE
ADA	AMERICANS WITH DISABILITIES ACT
ADMIN	ADMINISTRATION
AFC	ABOVE FINISHED COUNTER
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AFS	ABOVE FINISHED SLAB
AGGR	AGGREGATE
AHU	AIR HANDLING UNIT
AIB	AIR INFILTRATION BARRIER
ALT	ALTERNATE
ALUM	ALUMINUM
ANOD	ANODIZE
APC	ACOUSTICAL PANEL CEILING
APPROX	APPROXIMATE
ARCH	ARCHITECT
ASSY	ASSEMBLY
ATC	ACOUSTICAL TILE CEILING
AVG	AVERAGE
AW	ARCHITECTURAL WOODWORK
B	
BB	BASEBOARD
BC	BOOKCASE
BD	BOARD
BDRY	BOUNDARY
BFF	BELOW FINISH FLOOR
BHMA	BUILDER'S HARDWARE MANUFACTURER'S ASSOCIATION
BLDG	BUILDING
BLKG	BLOCKING
BLT IN	BUILT-IN
BN	BULLNOSE
BOS	BOTTOM OF STEEL
BOT	BOTTOM
BP	BUILDING PAPER
BRKT	BRACKET
BSMT	BASEMENT
BTWN	BETWEEN
BUR	BUILT-UP ROOFING
C	
C CONC	CAST CONCRETE
C LABEL	CLASS C DOOR
CAB	CABINET
CATW	CATWALK
CAV	CAVITY
CBB	CEMENTITIOUS (BACKER) BOARD
CD	CONSTRUCTION DOCUMENTS
CDW	CHILLED DRINKING WATER
CEM PLAS	CEMENT PLASTER
CER	CERAMIC
CF	CONTRACTOR FURNISHED
CF/CI	CONTRACTOR FURNISHED/ CONTRACTOR INSTALLED
CFE	CONTRACTOR FURNISHED EQUIPMENT
CFLG	COUNTERFLASHING
CFM	CUBIC FEET PER MINUTE
CFMF	COLD-FORMED METAL FRAMING
CFS	CUBIC FEET PER SECOND
CG	CORNER GUARD
CI	CAST IRON
CIP	CAST-IN-PLACE
CJ	CONTROL JOINT
CL	CENTER LINE
CLG	CEILING
CLG DIFF	CEILING DIFFUSER
CLG HT	CEILING HEIGHT
CLL	COLUMN LINE
CLO	CLOSET
CLR	COLOR
CLRM	CLASSROOM
CMU	CONCRETE MASONRY UNIT
CNDS	CONDENSATE
CDR	CARD READER
CO	CLEANOUT
COL	COLUMN
COMM	COMMUNICATION
CONC	CONCRETE
CONC FLR	CONCRETE FLOOR
CONF	CONFERENCE
CONT	CONTINUE
COORD	COORDINATE
COR	CONTRACTING OFFICER'S REPRESENTATIVE
CORR	CORRIDOR
CP	CONCRETE PIPE
CPT	CARPET
CR	CONTROL ROOM
CS	CAST STONE
CSWK	CASEWORK
CT	CERAMIC TILE
CTB	CERAMIC TILE BASE
CTF	CERAMIC TILE FLOOR
CTR	CENTER
CU FT	CUBIC FEET
CW	CASEMENT WINDOW
D	
D	DEPTH
D LABEL	CLASS D DOOR
DBL	DOUBLE
DEMO	DEMOLITION
DEPT	DEPARTMENT
DET	DETAIL
DIA	DIAMETER
DIR	DIRECTION
DIST	DISTANCE
DOC	DOCUMENT
DR	DOOR
DS	DOWNSPOUT

E	
EA	EACH
EF	EACH FACE
EIFS	EXTERIOR INSULATION AND FINISH SYSTEM
EJ	EXPANSION JOINT
ES	EACH SIDE
EL	ELEVATION
ELEV	ELEVATOR
ENTR	ENTRANCE
EPS	EXPANDED POLYSTYRENE BOARD (INSULATION)
EQ	EQUAL
EWC	ELECTRIC WATER COOLER
EXP	EXPOSED
EXT	EXTERIOR
EXT	EXTINGUISHER
EXT GR	EXTERIOR GRADE
F	
FA	FIRE ALARM
FAAP	FIRE ALARM ANNUNCIATOR PANEL
FAS BD	FASCIA BOARD
FC BRK	FACE BRICK
FCO	FLOOR CLEANOUT
FD	FLOOR DRAIN
FDTN	FOUNDATION
FEB	FIRE EXTINGUISHER ON BRACKET
FEC	FIRE EXTINGUISHER CABINET
FED	FEDERAL
FF	FINISH FACE
FF EL	FINISH FLOOR ELEVATION
FF INSUL	FOIL BACKED INSULATION
FGL	FIBERGLASS
FH	FIRE HOSE
FHP	FULL HEIGHT PARTITION
FIN	FINISH
FIN BS	FINISH BOTH SIDES
FIN FLR	FINISH FLOOR
FIN GR	FINISH GRADE
FIXT	FIXTURT-IN
FLDG	FOLDING
FLEX	FLEXIBLE
FLG	FLOORING
FLMT	FLUSH MOUNT
FLR	FLOOR
FM	FACTORY MUTUAL
FOC	FACE OF CONCRETE
FOM	FACE OF MASONRY
FRFIRE	RESISTANT
FRG	FIBER REINFORCED GYPSUM
FRMG	FRAMING
FRP	FIBERGLASS REINFORCED PLASTIC
FRTW	FIRE RETARDANT TREATED WOOD
FS	FEDERAL SPECIFICATION
FSTNR	FASTENER
FT	FEET
FTG	FOOTING
FWC	FABRIC WALLCOVERING
G	
G	NATURAL GAS
GALV	GALVANIZED
GB	GRAB BAR
GFCI	GOVERNMENT FURNISHED/ CONTRACTOR INSTALLED
GFGI	GOVERNMENT FURNISHED/ GOVERNMENT INSTALLED
GFRG	GLASS-FIBER-REINFORCED GYPSUM
GLZ	GLAZING
GR FL	GROUND FLOOR
GUT	GUTTER
GYP BD	GYPSUM BOARD
GYP PLAS	GYPSUM PLASTER
H	
HB	HOSE BIBB
HDPE	HIGH DENSITY POLYETHYLENE
HDW	HARDWARE
HDWD	HARDWOOD
HEPA	HIGH EFFICIENCY PARTICULATE AIR (FILTER)
HM	HOLLOW METAL
HMD	HOLLOW METAL DOOR
HORIZ	HORIZONTAL
HT	HEIGHT
HYDR	HYDRAULIC
I	
IBC	INTERNATIONAL BUILDING CODE
INSUL	INSULATION
INT	INTERIOR
ILO	IN LIEU OF
J	
JAN	JANITOR
K	
KPD	KEYPAD
KIT	KITCHEN
KPL	KICKPLATE
L	
LAM	LAMINATE
LAV	LAVATORY
LBR	LUMBER
LBS	POUND
LDG	LANDING
LF	LINEAR FEET (FOOT)
LIB	LIBRARY
LIN	LINEAR
LKR	LOCKER
LOC	LOCATION
LT	LIGHT
LVDR	LOUVER DOOR
LVR	LOUVER

M	
MACH RM	MACHINE ROOM
MATL	MATERIAL
MAX	MAXIMUM
MC	MOISTURE CONTENT
MD	METAL DECK
MECH	MECHANICAL
MECH RM	MECHANICAL ROOM
MEMB	MEMBRANE
MF	MILL FINISH
MFR	MANUFACTURER
MID	MIDDLE
MIL STD	MILITARY STANDARD
MIN	MINIMUM, MINUTE
MIRR	MIRROR
MISC	MISCELLANEOUS
MLDG	MOLDING (MOULDING)
MO	MASONRY OPENING
MOD	MODIFY
MB	MOISTURE BARRIER
MTG	MOUNTING
MTL	METAL
MVBL	MOVABLE
MWP	MEMBRANE WATERPROOFING
N	
N	NORTH
NA	NOT APPLICABLE
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NIC	NOT IN CONTRACT
NO	NUMBER
NOM	NOMINAL
NPNO	PAINT
NRC	NOISE REDUCTION COEFFICIENT
NTS	NOT TO SCALE
O	
OA	OVERALL
OC	ON CENTER
OD	OUTSIDE DIAMETER
OFD	OVERFLOW DRAIN
OFF	OFFICE
OGL	OBSCURE GLASS
OH	OPPOSITE HAND
OPNG	OPENING
OPP	OPPOSITE
OPQ	OPAQUE
OWSJ	OPEN WEB STEEL JOIST
OPR	OPERABLE
ORD	OVERFLOW ROOF DRAIN
ORIG	ORIGINAL
P	
PA	PUBLIC ADDRESS
PAR	PARAPET
PAT	PATTERN
PB	PULL BOX
PBD	PARTICLEBOARD
PCC	PRECAST CONCRETE
PCF	POUNDS PER CUBIC FOOT
PCT	PERCENT
PERF	PERFORATED
PERIM	PERIMETER
PH	PHASE
PIL	PILASTER
PL	PROPERTY LINE
PL GL	PLATE GLASS
PLAM	PLASTIC LAMINATE
PLAS	PLASTER
PLBG	PLUMBING
PLG	PILING
PLYWD	PLYWOOD
PNL	PANEL
PP PL	PUSH/PULL PLATE
PR	PAIR
PRCST	PRECAST
PRKG	PARKING
PS CONC	PRESTRESSED CONCRETE
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PT	PRESSURE TREATED
PTD	PAPER TOWEL DISPENSER
PTDR	PAPER TOWEL DISPENSER AND RECEPTACLE
PTN	PARTITION
PVC	POLYVINYL CHLORIDE (PLASTIC)
PWR	POWER
Q	
QT	QUARRY TILE
QTY	QUANTITY
R	
RB	RESILIENT BASE
RBM	REINFORCED BRICK MASONRY
RBR	RUBBER
RC	REINFORCED CONCRETE
RCP	REFLECTED CEILING PLAN
RD	ROOF DRAIN
RDG INS	RIGID INSULATION, SOLID
REC	RECESSED
REC RM	RECREATION ROOM
REF	REFERENCE
REM	REMOVABLE
REP	REPAIR
REPL	REPLACE
REQ	REQUIRE
REQD	REQUIRED
RESIL	RESILIENT
REST	RESTROOM
RF	RESILIENT FLOORING
RFG	ROOFING
RH	ROOF HATCH
RHR	RIGHT HAND REVERSE
RL	ROOF LEADER
RLG	RAILING
RM	ROOM
RO	ROUGH OPENING
RSD	ROLLING STEEL DOOR
RV	ROOF VENT
RVL	REVEAL

S	
SB	SPLASH BLOCK
SCHED	SCHEDULE
SD	SMOKE DETECTOR
SF	SQUARE FOOT (FEET)
SFTWD	SOFTWOOD
SGL	SINGLE
SHT MTL	FLASH SHEET METAL (FLASHING)
SHTHG	SHEATHING
SHV	SHELVING
SIM	SIMILAR
SJ	SCORED JOINT
SKLT	SKYLIGHT
SLNT	SEALANT
SMK	SMOKE
SMLS	SEAMLESS
SP EL	SPOT ELEVATION
SPEC	SPECIFICATION
SQ	SQUARE
SQ IN	SQUARE INCH
SQ YD	SQUARE YARD
SST	STAINLESS STEEL
ST	STAIRS
STD	STANDARD
STL JST	STEEL JOIST
STL RF DK	STEEL ROOF DECK
STOR	STORAGE
STR	STRINGERS
STRB/HRN	STROBE/HORN
SUB FL	SUBFLOOR
SV	SHEET VINYL
SW	SIDEWALK
T	
T	TREAD
T/S	TUB/SHOWER
TC	TERRA COTTA
TD	TRENCH DRAIN
TEL	TELEPHONE
TEMP	TEMPORARY
TER	TERRAZZO
TFF	TOP OF FINISH FLOOR
THK	THICKNESS
TK BD	TACKBOARD
TMPD GL	TEMPERED GLASS
TN	TRUE NORTH
TOF	TOP OF FOOTING
TOM	TOP OF MASONRY
TOP	TOP OF PARAPET
TOPO	TOPOGRAPHY
TOS	TOP OF SLAB
TRANS	TRANSOM
TRTD	TREATED
TV	TELEVISION
TYP	TYPICAL
U	
UL	UNDERWRITER'S LABORATORY
UNO	UNLESS NOTED OTHERWISE
UTIL	UTILITY
V	
VERT	VERTICAL
VENT	VENTILATION
VIF	VERIFY IN FIELD
VOC	VOLATILE ORGANIC COMPOUND
VOL	VOLUME
W	
WB	WOOD BASE
WC	WATER CLOSET
WD	WOOD
WF	WIDE FLANGE
WT	WEIGHT
WWF	WELDED WIRE FABRIC
WWM	WELDED WIRE MESH

ANNOTATION CALLOUTS/DRAWING SYMBOLS



GENERAL PROJECT NOTES

1 ALL WORK SHALL CONFORM WITH APPLICABLE BUILDING CODES, REGULATIONS, AND ORDINANCES. CONTRACTOR SHALL OBTAIN ALL REQUIRED PERMITS.

2 THE CONTRACTOR IS RESPONSIBLE TO PERFORM A COMPLETE ANALYSIS PRIOR TO COMMENCEMENT OF WORK. REPORT ALL DISCREPANCIES TO THE CONTRACTING OFFICERS REPRESENTATIVE IMMEDIATELY. FAILURE OF THE CONTRACTOR TO PERFORM SURVEY, FIELD VERIFY CONDITIONS, AND COORDINATE WORK DOES NOT RELIEVE CONTRACTOR OF RESPONSIBLITY FOR WORK.

3 CONTRACTOR SHALL TAKE PRECAUTIONS TO MAINTAIN AND PROTECT EXISTING SYSTEMS AND FINISHES WHICH ARE TO REMAIN. ANY DAMAGES TO SUCH SYSTEMS AND FINISHES SHALL BE REPAIRED IN A MANNER ACCEPTABLE TO THE CONTRACTING OFFICERS REPRESENTATIVE AT THE CONTRACTORS EXPENSE.

4 DRAWINGS CONTAINED IN THIS SET SHALL NOT BE REPRODUCED FOR SHOP DRAWINGS. COPIES OF THESE DRAWINGS SUBMITTED AS SHOP DRAWINGS WILL BE REJECTED AND RETURNED TO THE CONTRACTOR.

5 CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR THE MEANS, METHODS, AND SEQUENCES OF CONSTRUCTION AND THE SAFETY OF ALL CONSTRUCTION PERSONNEL AND VISITORS.

6 "TYPICAL" AS USED IN THESE DOCUMENTS SHALL MEAN THAT THE CONDITIONS OR DIMENSION IS THE SAME OR REPRESENTATIVE FOR SIMILAR CONDITIONS THROUGHOUT.

7 ALL FIRE, LIFE-SAFETY SYSTEMS MUST BE MAINTAINED IN PROPER WORKING ORDER THROUGHOUT THE DURATION OF THE WORK. PORTABLE FIRE EXTINGUISHERS OF APPROVED TYPE ARE TO BE PLACED WITHIN THE CONSTRUCTION AREA IN ACCORDANCE WITH THE LOCAL FIRE DEPARTMENT INSPECTOR OR MARSHAL.

8 ALL EXISTING SECURITY SYSTEMS SHALL BE MAINTAINED IN PROPER WORKING ORDER THROUGHOUT THE DURATION OF THE WORK. THESE SYSTEMS SHALL BE PROTECTED DURING CONSTRUCTION. CONTRACTOR TO NOTIFY THE CONTRACTING OFFICERS REPRESENTATIVE (COR) IMMEDIATELY OF ANY DAMAGE TO THE SECURITY SYSTEMS OR SYSTEM OUTAGES.

CHRISTINA PAZ GARCIA
5962
07/02/2024
KANSAS
ARCHITECT

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. COUGHLIN
DRAWN BY: K. COUGHLIN
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SUBMITTED BY: YAEGER ARCH
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ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0086
CONTRACT NO.: TBD

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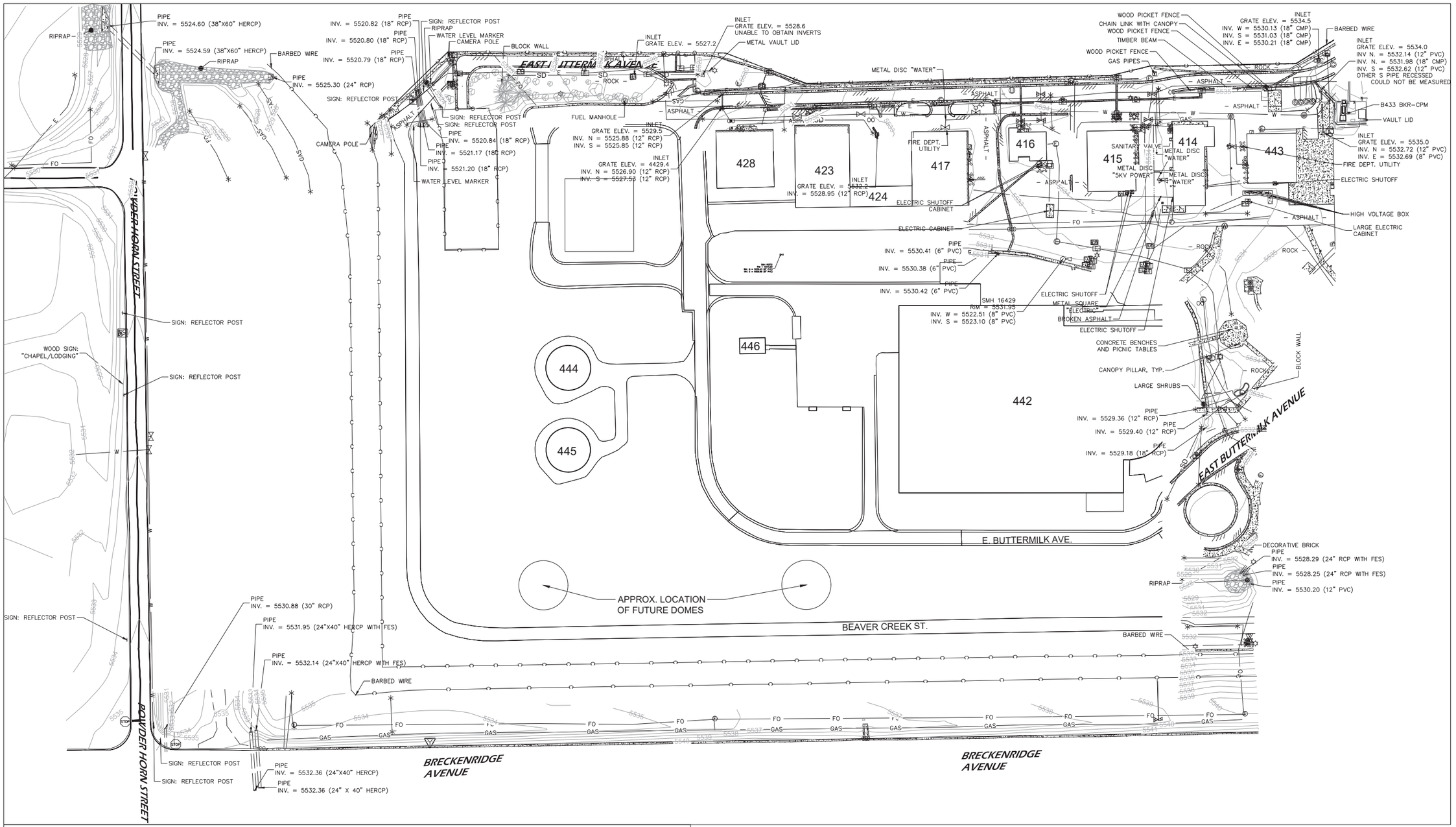
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

GENERAL NOTES, ABBREVIATIONS

SHEET ID
GI002

READY-TO-ADVERTISE (RTA) SUBMITTAL



LEGEND

AC UNIT	GAS METER	STEEL POST		FENCE		FOUND ELECTRIC
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE		HIGH SECURITY FENCE		FOUND COMMUNICATIONS
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE		FLOW LINE		FOUND GAS LINE
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK		GAS LOCATE		FOUND SANITARY SEWER
LIGHT POLE	SANITARY MANHOLE	FENCE GATE		GUARD RAIL		FOUND STORM SEWER
ELECTRIC CABINET	SANITARY CLEANOUT	CURB CUT		EDGE OF LANDSCAPING		FOUND WATER LINE
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN		EDGE OF GRAVEL		FOUND UNK. UTILITY
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP		PIPE		INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY
ELECTRIC BOX	WATER VALVE	EDGE OF ASPHALT	W	WATER LOCATE		
FIBER OPTIC MANHOLE	FIRE HYDRANT	DRAINAGE LINE		MAJOR CONTOUR		
FIBER OPTIC VAULT	ROOF DRAIN	ELECTRIC LOCATE		MINOR CONTOUR		
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE	FIBER OPTIC LOCATE				

NOTE:

EXISTING CONDITIONS BASED ON TOPOGRAPHIC SURVEY PREPARED AND PERFORMED BY MAJESTIC SURVEYING DATED 10.18.2023 WITH INTERIOR SITE CONDITIONS DEPICTED HERE FROM BASE GIS/CAD DATA.

A11 OVERALL EXISTING CONDITIONS
1" = 60'

PLAN NORTH

0 60' 120'
SCALE: 1" = 60'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. ROBICHAUD-POST
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8555 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-814-2000

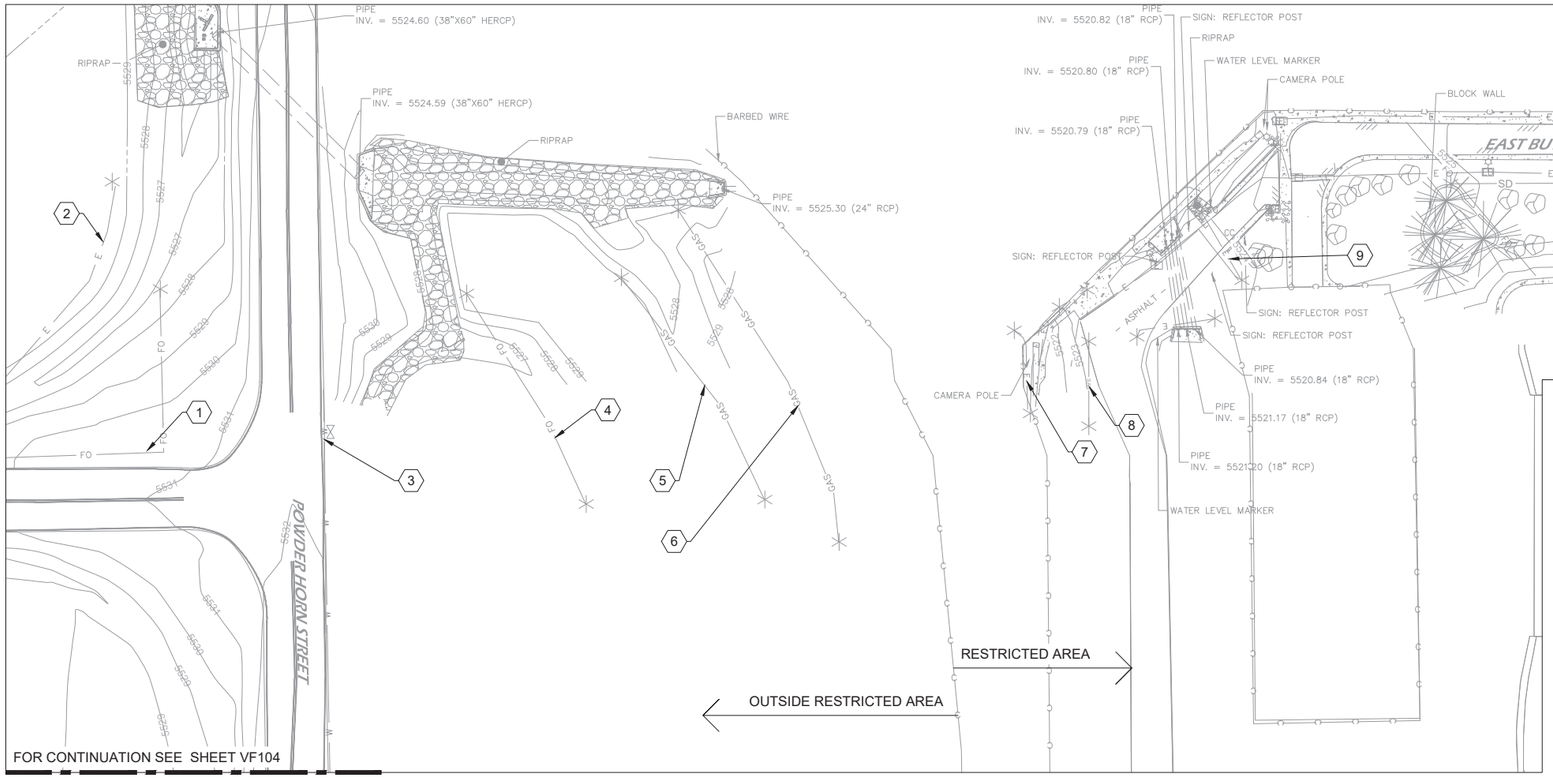
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

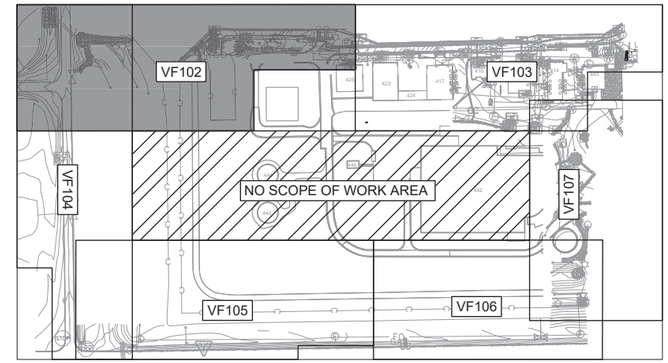
OVERALL EXISTING CONDITIONS

SHEET ID
VF101

READY-TO-ADVERTISE (RTA) SUBMITTAL

CUI





KEY MAP

LEGEND

AC UNIT	GAS METER	STEEL POST		FENCE		FOUND ELECTRIC	
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE		HIGH SECURITY FENCE		FOUND COMMUNICATIONS	
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE		FLOW LINE		FOUND GAS LINE	
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK	GAS	GAS LOCATE		FOUND SANITARY SEWER	
LIGHT POLE	SANITARY MANHOLE	FENCE GATE		GUARD RAIL		FOUND STORM SEWER	
ELECTRIC CABINET	SANITARY CLEANOUT	CC CURB CUT		EDGE OF LANDSCAPING		FOUND WATER LINE	
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN		EDGE OF GRAVEL		FOUND UNK. UTILITY	
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP		PIPE		INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY	
ELECTRIC BOX	WATER VALVE	EDGE OF ASPHALT		WATER LOCATE			
FIBER OPTIC MANHOLE	FIRE HYDRANT	D DRAINAGE LINE		MAJOR CONTOUR			
FIBER OPTIC VAULT	RD ROOF DRAIN	E ELECTRIC LOCATE		MINOR CONTOUR			
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE	FO FIBER OPTIC LOCATE					

NOTE:

EXISTING CONDITIONS BASED ON TOPOGRAPHIC SURVEY PREPARED AND PERFORMED BY MAJESTIC SURVEYING DATED 10.18.2023

POTHOLE DATA TABLE

POTHOLE #	UTILITY	MATERIAL	SIZE	DEPTH	NOTE
1	COMM.	---	¼"	3'-9"	DIRECT BURIED COMM. LINE
2	ELECTRIC	CONCRETE	N/A	2'-6"	CONCRETE ENCASED ELEC. 30" TO TOP
3	WATER	---	---	6'-0"	POTHOLED TO 6' DEPTH, NOT FOUND. OPERATOR NUT LOCATED ON VALVE AT 6' DEPTH
4	COMM.	---	---	N/A	POTHOLED TO 5' DEPTH, NOT FOUND. UNTRACEABLE
5	GAS	---	---	N/A	POTHOLED TO 5' DEPTH, NOT FOUND.
6	GAS	STEEL	6"	2'-0"	
7	ELEC./COMM.	CONCRETE	N/A	0'-2"	CONCRETE ENCASED ELEC. & COMM. 2" TO TOP
8	SANITARY	---	---	N/A	POTHOLED TO 10' DEPTH, NOT FOUND.
9	ELECTRIC	CONCRETE	N/A	3'-0"	CONCRETE ENCASED ELEC. 36" TO TOP
10	ELECTRIC	---	---	N/A	POTHOLED TO 6' DEPTH, NOT FOUND.
11	ELECTRIC	---	---	N/A	POTHOLED TO 6' DEPTH, NOT FOUND.
12	WATER	STEEL	8"	5'-0"	
13	ELECTRIC	PVC	12"	7'-3"	
14	GAS	PVC	8"	4'-9"	
15	ELECTRIC	CONCRETE	N/A	3'-8"	CONCRETE ENCASED ELEC. 44" TO TOP
16	WATER	PVC	8"	5'-4"	

A9 ENLARGED EXISTING CONDITIONS AREA 1
1" = 30'

PLAN NORTH

0 30' 60'
SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: B. WILKINSON
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-8800

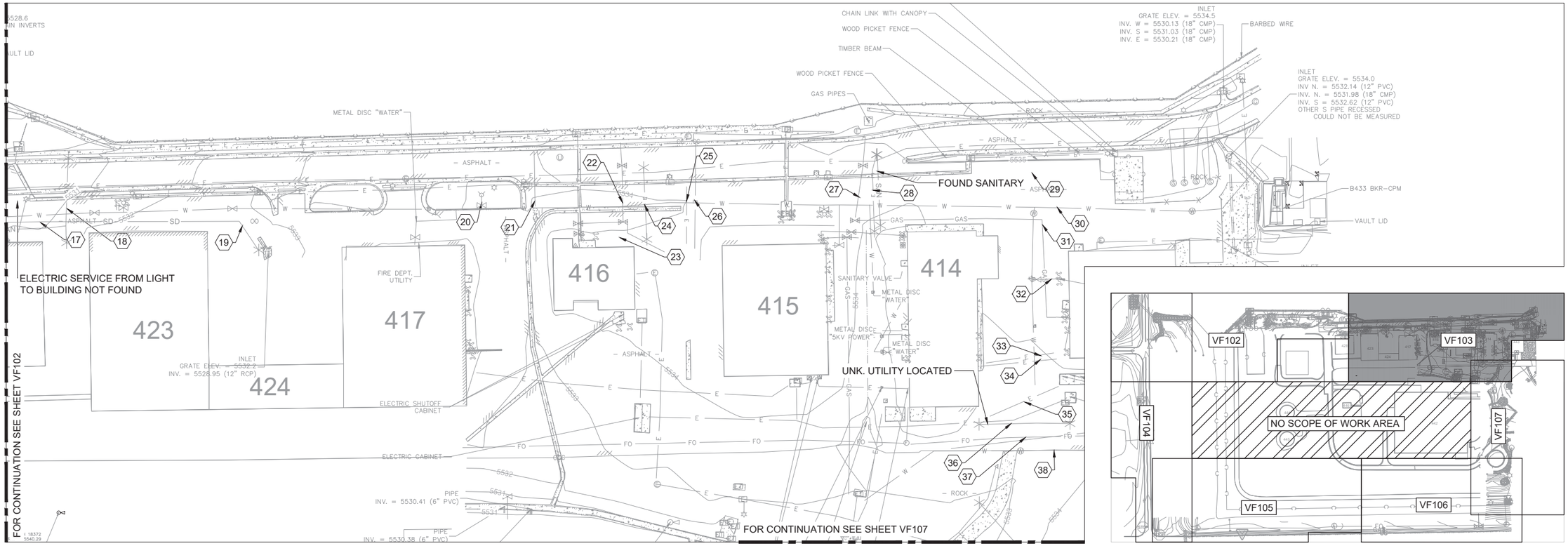
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ENLARGED EXISTING CONDITIONS AREA
1

SHEET ID
VF102

READY-TO-ADVERTISE (RTA) SUBMITTAL

CUI



KEY MAP

LEGEND

AC UNIT	GAS METER	STEEL POST	FENCE	FOUND ELECTRIC	
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE	HIGH SECURITY FENCE	FOUND COMMUNICATIONS	
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE	FLOW LINE	FOUND GAS LINE	
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK	GAS LOCATE	FOUND SANITARY SEWER	
LIGHT POLE	SANITARY MANHOLE	FENCE GATE	GUARD RAIL	FOUND STORM SEWER	
ELECTRIC CABINET	SANITARY CLEANOUT	CURB CUT	EDGE OF LANDSCAPING	FOUND WATER LINE	
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN	EDGE OF GRAVEL	FOUND UNK. UTILITY	
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP	PIPE		
ELECTRIC BOX	WATER VALVE	EDGE OF ASPHALT	WATER LOCATE		
FIBER OPTIC MANHOLE	FIRE HYDRANT	DRAINAGE LINE	MAJOR CONTOUR		
FIBER OPTIC VAULT	ROOF DRAIN	ELECTRIC LOCATE	MINOR CONTOUR		
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE	FIBER OPTIC LOCATE			

INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY

NOTE:

EXISTING CONDITIONS BASED ON TOPOGRAPHIC SURVEY PREPARED AND PERFORMED BY MAJESTIC SURVEYING DATED 10.18.2023

POTHOLE DATA TABLE

POTHOLE #	UTILITY	MATERIAL	SIZE	DEPTH	NOTE
17	STORM	---	---	N/A	POTHOLED TO 5', NOT FOUND.
18	SANITARY	---	---	N/A	POTHOLED TO 8', NOT FOUND.
19	STORM	PVC	10"	3'-0"	
20	WATER	STEEL	8"	6'-6"	
21	GAS	PVC	8"	3'-4"	
22	GAS	STEEL	1 ½"	3'-6"	
23	ELECTRIC	---	¼"	1'-4"	DIRECT BURY, TWO LINES IN PARALLEL
24	ELECTRIC	CONCRETE	N/A	3'-0"	CONCRETE ENCASED ELEC. 36" TO TOP
25	ELECTRIC	CONCRETE	N/A	0'-4"	CONCRETE ENCASED ELEC. 4" TO TOP
26	ELECTRIC	CONCRETE	N/A	2'-0"	CONCRETE ENCASED ELEC. 24" TO TOP
27	GAS	STEEL	8"	3'-0"	
28	ELECTRIC	CONCRETE	N/A	1'-0"	CONCRETE ENCASED ELEC. 12" TO TOP
29	COMM	---	---	N/A	POTHOLED TO 6', NOT FOUND
30	WATER	PVC	8"	5'-0"	
31	GAS	STEEL	6"	3'-0"	
32	WATER	PVC	8"	4'-8"	
33	ELECTRIC	PVC	¾"	2'-6"	
34	ELECTRIC	---	---	N/A	FLOW FILL ENCOUNTERED 1.5' DEPTH
35	ELECTRIC	CONCRETE	N/A	1'-8"	CONCRETE ENCASED ELEC. 20" TO TOP
36	ELECTRIC	---	---	N/A	POTHOLED TO 6', NOT FOUND
37	COMM	CONCRETE	N/A	1'-0"	CONCRETE ENCASED COMM 12" TO TOP
38	WATER	---	---	N/A	POTHOLED TO 7', NOT FOUND. CONCRETE ENCASEMENT FOUND AT 48" DEPTH

A9 ENLARGED EXISTING CONDITIONS AREA 2
1" = 30'

PLAN NORTH

0 30' 60'
SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: B. WILLOUGHBY
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-8800

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ENLARGED EXISTING CONDITIONS AREA 2

SHEET ID
VF103

READY-TO-ADVERTISE (RTA) SUBMITTAL

KEY MAP

LEGEND

AC UNIT	GAS METER	STEEL POST	FENCE	FOUND ELECTRIC	
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE	HIGH SECURITY FENCE	FOUND COMMUNICATIONS	
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE	FLOW LINE	FOUND GAS LINE	
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK	GAS LOCATE	FOUND SANITARY SEWER	
LIGHT POLE	SANITARY MANHOLE	FENCE GATE	GUARD RAIL	FOUND STORM SEWER	
ELECTRIC CABINET	SANITARY CLEANOUT	CURB CUT	EDGE OF LANDSCAPING	FOUND WATER LINE	
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN	EDGE OF GRAVEL	FOUND UNK. UTILITY	
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP	PIPE		
ELECTRIC BOX	WATER VALVE	EDGE OF ASPHALT	WATER LOCATE	INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY	
FIBER OPTIC MANHOLE	FIRE HYDRANT	DRAINAGE LINE	MAJOR CONTOUR		
FIBER OPTIC VAULT	ROOF DRAIN	ELECTRIC LOCATE	MINOR CONTOUR		
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE	FIBER OPTIC LOCATE			

NOTE:

EXISTING CONDITIONS BASED ON TOPOGRAPHIC SURVEY PREPARED AND PERFORMED BY MAJESTIC SURVEYING DATED 10.18.2023

POTHOLE DATA TABLE

POTHOLE #	UTILITY	MATERIAL	SIZE	DEPTH	NOTE
39	WATER	---	---	N/A	POTHOLED TO 6', NOT FOUND. OPERATING NUT LOCATED AT 7'.
40	UNK	---	---	N/A	POTHOLED TO 5', NOT FOUND.
1	COMM.	---	¼"	3'-9"	DIRECT BURIED COMM. LINE
2	ELECTRIC	CONCRETE	N/A	2'-6"	CONCRETE ENCASED ELEC. 30" TO TOP
3	WATER	---	---	6'-0"	POTHOLED TO 6' DEPTH, NOT FOUND. OPERATOR NUT LOCATED ON VALVE AT 6' DEPTH
4	COMM.	---	---	N/A	POTHOLED TO 5' DEPTH, NOT FOUND. UNTRACEABLE

A9 ENLARGED EXISTING CONDITIONS AREA 3
1" = 30'

PLAN NORTH

0 30' 60'
SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: ERIN WOOD
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-8000

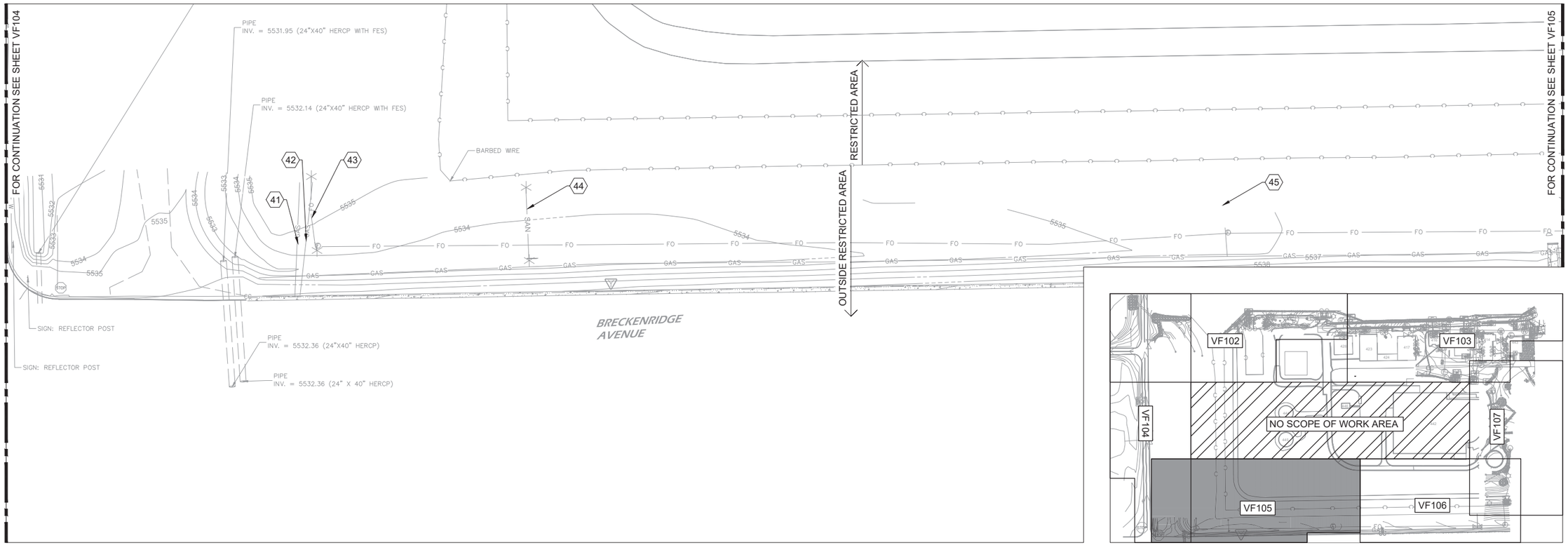
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ENLARGED EXISTING CONDITIONS AREA 3

SHEET ID

VF104

READY-TO-ADVERTISE (RTA) SUBMITTAL



KEY MAP

LEGEND

AC UNIT	GAS METER	STEEL POST		FENCE	
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE		HIGH SECURITY FENCE	
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE		FLOW LINE	
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK	GAS	GAS LOCATE	
LIGHT POLE	SANITARY MANHOLE	FENCE GATE		GUARD RAIL	
ELECTRIC CABINET	SANITARY CLEANOUT	CC CURB CUT		EDGE OF LANDSCAPING	
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN		EDGE OF GRAVEL	
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP		PIPE	
ELECTRIC BOX	WATER VALVE	EDGE OF ASPHALT	W	WATER LOCATE	
FIBER OPTIC MANHOLE	FIRE HYDRANT	D DRAINAGE LINE		MAJOR CONTOUR	
FIBER OPTIC VAULT	RD ROOF DRAIN	E ELECTRIC LOCATE		MINOR CONTOUR	
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE	FO FIBER OPTIC LOCATE			

FOUND ELECTRIC
FOUND COMMUNICATIONS
FOUND GAS LINE
FOUND SANITARY SEWER
FOUND STORM SEWER
FOUND WATER LINE
FOUND UNK. UTILITY

INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY

NOTE:

EXISTING CONDITIONS BASED ON TOPOGRAPHIC SURVEY PREPARED AND PERFORMED BY MAJESTIC SURVEYING DATED 10.18.2023

POTHOLE DATA TABLE

POTHOLE #	UTILITY	MATERIAL	SIZE	DEPTH	NOTE
41	GAS	---	---	N/A	POTHOLED TO 5', NOT FOUND.
42	GAS	STEEL	6"	2'-6"	
43	COMM.	CONCRETE	N/A	2'-0"	CONCRETE ENCASED COMM. 24" TO TOP
44	SANITARY	CLAY	12"	4'-9"	FOUND SANITARY SEWER
45	GAS	---	---	N/A	POTHOLED TO 5', NOT FOUND.

A9 ENLARGED EXISTING CONDITIONS AREA 4
1" = 30'

PLAN NORTH

0 30' 60'
SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: BRIAN WORT
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

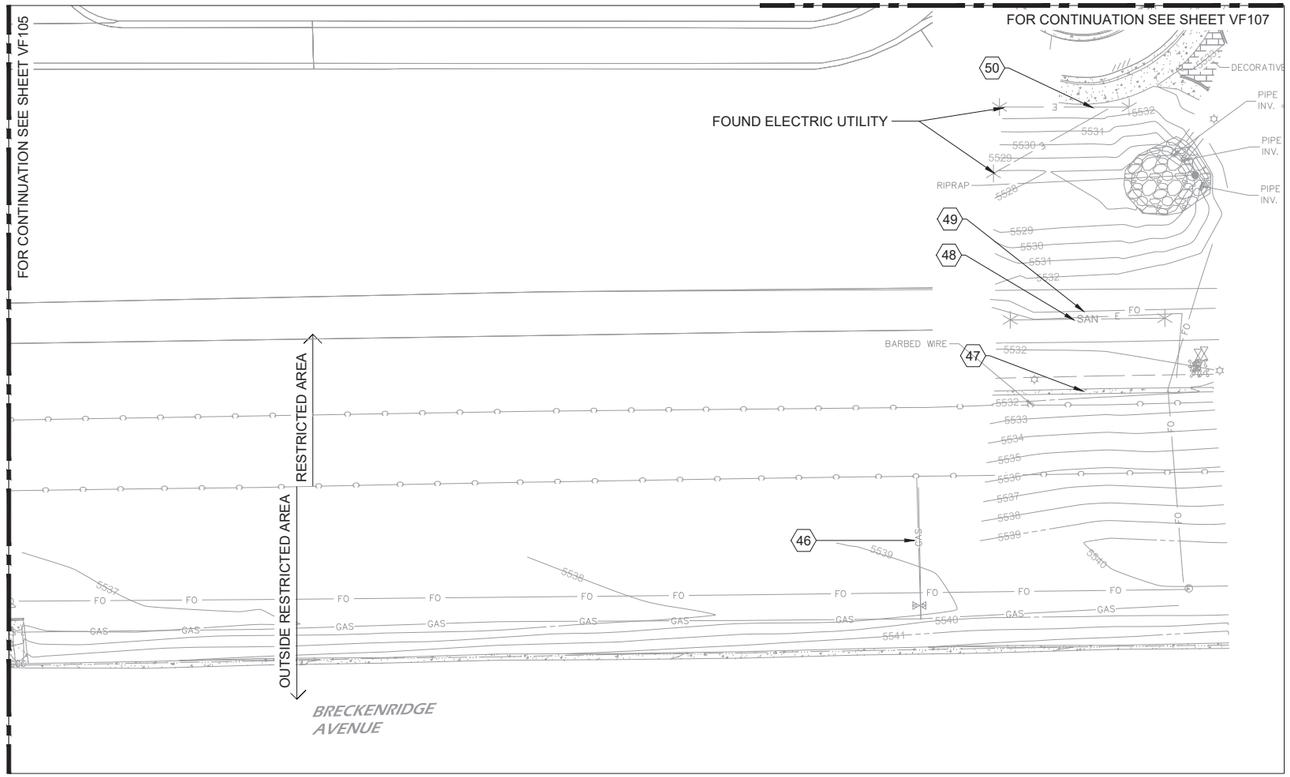
YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-422-8300

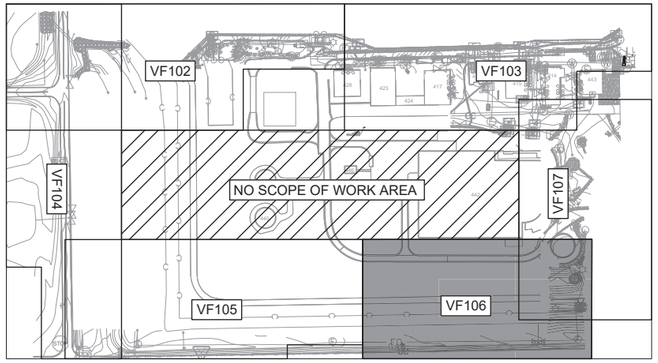
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ENLARGED EXISTING CONDITIONS AREA 4

SHEET ID
VF105

READY-TO-ADVERTISE (RTA) SUBMITTAL





KEY MAP

LEGEND

AC UNIT	GAS METER	STEEL POST		FENCE		FOUND ELECTRIC
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE		HIGH SECURITY FENCE		FOUND COMMUNICATIONS
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE		FLOW LINE		FOUND GAS LINE
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK		GAS LOCATE		FOUND SANITARY SEWER
LIGHT POLE	SANITARY MANHOLE	FENCE GATE		GUARD RAIL		FOUND STORM SEWER
ELECTRIC CABINET	SANITARY CLEANOUT	CC CURB CUT		EDGE OF LANDSCAPING		FOUND WATER LINE
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN		EDGE OF GRAVEL		FOUND UNK. UTILITY
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP		PIPE		
ELECTRIC BOX	WATER VALVE		EDGE OF ASPHALT	WATER LOCATE		INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY
FIBER OPTIC MANHOLE	FIRE HYDRANT		DRAINAGE LINE	MAJOR CONTOUR		
FIBER OPTIC VAULT	RD ROOF DRAIN		ELECTRIC LOCATE	MINOR CONTOUR		
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE		FIBER OPTIC LOCATE			

POTHOLE DATA TABLE

POTHOLE #	UTILITY	MATERIAL	SIZE	DEPTH	NOTE
46	GAS	PVC	6"	3'-2"	
47	ELECTRIC	CONCRETE	24"	12"	CONCRETE ENCASED ELEC. AT SURFACE
48	SANITARY	---	---	N/A	FLOW FILL ENCOUNTERED AT 2"
49	ELEC/COMM	---	---	N/A	FLOW FILL ENCOUNTERED AT 2"
50	ELECTRIC	PVC	1"	2'-7"	

NOTE:

EXISTING CONDITIONS BASED ON TOPOGRAPHIC SURVEY PREPARED AND PERFORMED BY MAJESTIC SURVEYING DATED 10.18.2023

A9 ENLARGED EXISTING CONDITIONS AREA 5
1" = 30'

PLAN NORTH

0 30' 60'
SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: E. WOLFORT
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

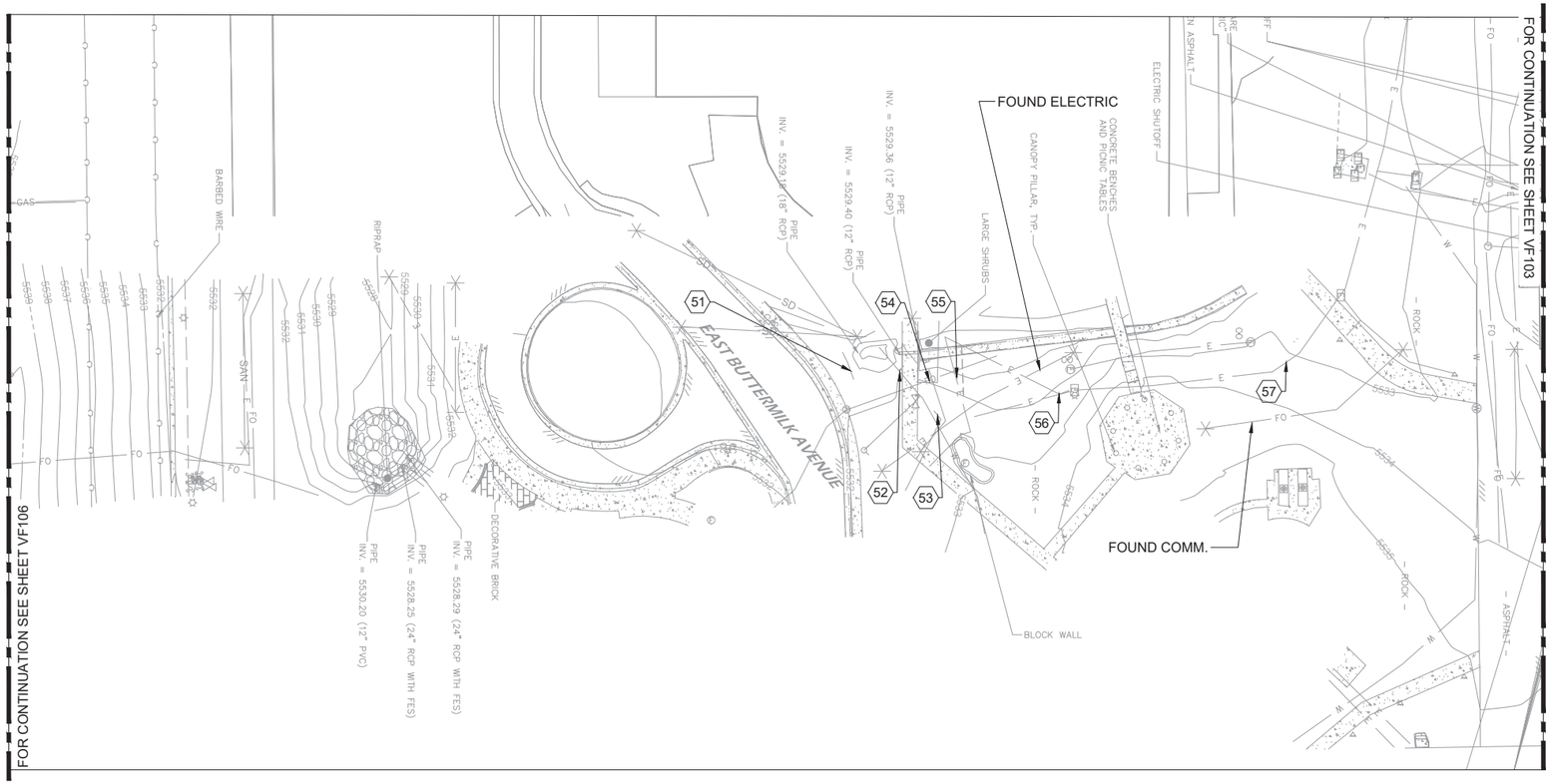
YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-422-8300

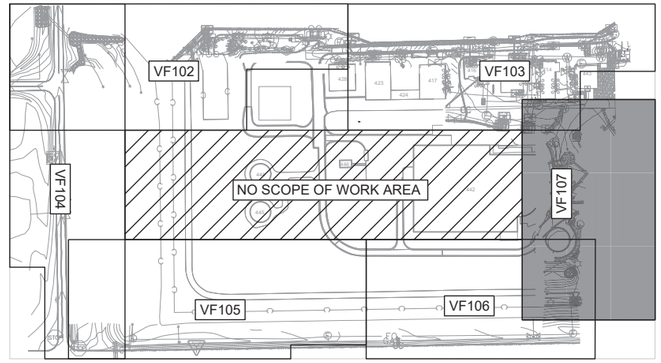
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ENLARGED EXISTING CONDITIONS AREA 5

SHEET ID
VF106

READY-TO-ADVERTISE (RTA) SUBMITTAL





KEY MAP

LEGEND

AC UNIT	GAS METER	STEEL POST		FENCE		FOUND ELECTRIC	
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE		HIGH SECURITY FENCE		FOUND COMMUNICATIONS	
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE		FLOW LINE		FOUND GAS LINE	
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK		GAS LOCATE		FOUND SANITARY SEWER	
LIGHT POLE	SANITARY MANHOLE	FENCE GATE		GUARD RAIL		FOUND STORM SEWER	
ELECTRIC CABINET	SANITARY CLEANOUT	CC CURB CUT		EDGE OF LANDSCAPING		FOUND WATER LINE	
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN		EDGE OF GRAVEL		FOUND UNK. UTILITY	
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP		PIPE			
ELECTRIC BOX	WATER VALVE		EDGE OF ASPHALT		WATER LOCATE		
FIBER OPTIC MANHOLE	FIRE HYDRANT		DRAINAGE LINE		MAJOR CONTOUR		
FIBER OPTIC VAULT	RD ROOF DRAIN		ELECTRIC LOCATE		MINOR CONTOUR		
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE		FIBER OPTIC LOCATE				

INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY

NOTE:

EXISTING CONDITIONS BASED ON TOPOGRAPHIC SURVEY PREPARED AND PERFORMED BY MAJESTIC SURVEYING DATED 10.18.2023

POTHOLE DATA TABLE

POTHOLE #	UTILITY	MATERIAL	SIZE	DEPTH	NOTE
51	IRRIGATION	PVC	2"	0'-7"	
52	WATER	PVC	8"	7'-0"	
53	ELECTRIC	PVC	1"	1'-9"	
54	COMM	CONCRETE	N/A	2'-3"	CONCRETE ENCASED COMM. TOP AT 27"
55	COMM	CONCRETE	N/A	1'-8"	CONCRETE ENCASED COMM. TOP AT 20"
56	ELECTRIC	PVC AND CONCRETE	2" AND N/A	30" AND 36"	SITE LIGHT AT 30" AND CONCRETE ENCASED ELEC. 36" TO TOP
57	ELECTRIC	---	3"	1'-3"	DIRECT BURIED ELECTRIC

A9 ENLARGED EXISTING CONDITIONS AREA 6

1" = 30'

PLAN NORTH

0 30' 60'

SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. HOLLOWAY
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-8000

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ENLARGED EXISTING CONDITIONS AREA 6

SHEET ID

VF107

READY-TO-ADVERTISE (RTA) SUBMITTAL

Geotechnical Engineering Report
Redundant Surveillance Mission Electrical Power Supply | Aurora, Colorado
June 2, 2023 | Terracon Project No. 25225138A

Exploration Plan

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

A9 OVERALL BORING LOCATIONS
NTS

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. BROCKHOFT
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W912BF24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-6300

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

OVERALL BORING LOCATIONS

SHEET ID
VF108

READY-TO-ADVERTISE (RTA) SUBMITTAL

Redundant Surveillance Mission Electrical Power Supply
East Breckenridge Avenue and South Powderhorn Street | Aurora, Colorado
Terracon Project No. 25225138A

Terracon
10625 W 170 Frontage Rd N
Ste 3
Wheat Ridge, CO

Boring Log No. PS-1

Location: See Exploration Plan
Latitude: 39.7155° Longitude: -104.7812°

Depth (Ft.)	Graphic Log	Model Layer	Water Level Observations	Sample Type	Field Test Results	SWELL (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
0		2								
2					11-16				41-15-26	76
3.5									36-16-20	83
5		4			10-13		9.3			
10					12-16		9.3	111		
					10-16		9.1	120		
15					10-15		5.3	106		
15.0										

FILL - LEAN CLAY (CL), with sand, brown to tan, very stiff

CLAYEY SAND (SC), fine to coarse grained, tan to brown, medium dense

Boring Terminated at 15 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes

Water Level Observations
None encountered while drilling

Advancement Method
4-inch diameter solid stem continuous flight power auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig CME-55
Hammer Type Automatic
Driller Terracon
Logged by DR
Boring Started 04-05-2023
Boring Completed 04-05-2023

Facilities | Environmental | **Geotechnical** | Materials

Redundant Surveillance Mission Electrical Power Supply
East Breckenridge Avenue and South Powderhorn Street | Aurora, Colorado
Terracon Project No. 25225138A

Terracon
10625 W 170 Frontage Rd N
Ste 3
Wheat Ridge, CO

Boring Log No. PS-2

Location: See Exploration Plan
Latitude: 39.7140° Longitude: -104.7802°

Depth (Ft.)	Graphic Log	Model Layer	Water Level Observations	Sample Type	Field Test Results	SWELL (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
0		4								
5					8-13		11.2	112	44-16-28	43
					10-18		13.6	119		
10					4-6		12.5	117		
					5-7		16.5	111		
15					7-8		9.7			
15.0										

CLAYEY SAND (SC), fine grained, brown, loose to medium dense

POORLY GRADED SAND (SP), fine to medium grained, tan, medium dense

Boring Terminated at 15 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes

Water Level Observations
None encountered while drilling

Advancement Method
4-inch diameter solid stem continuous flight power auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig CME-55
Hammer Type Automatic
Driller Terracon
Logged by DR
Boring Started 04-05-2023
Boring Completed 04-05-2023

Facilities | Environmental | **Geotechnical** | Materials

Redundant Surveillance Mission Electrical Power Supply
East Breckenridge Avenue and South Powderhorn Street | Aurora, Colorado
Terracon Project No. 25225138A

Terracon
10625 W 170 Frontage Rd N
Ste 3
Wheat Ridge, CO

Boring Log No. PS-3

Location: See Exploration Plan
Latitude: 39.7140° Longitude: -104.7777°

Depth (Ft.)	Graphic Log	Model Layer	Water Level Observations	Sample Type	Field Test Results	SWELL (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
0		3								
5					15-20		10.9		48-16-32	77
					8-9		11.8			
8.5					4-5		12.2	110		
10		4			4-4		9.6	98		
12.0		3								
15					5-9		14.8	116		
15.0										

LEAN CLAY (CL), with sand, brown, medium stiff to very stiff

POORLY GRADED SAND (SP), trace silt, fine to medium grained, tan, loose

SANDY LEAN CLAY (CL), brown, stiff

Boring Terminated at 15 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes

Water Level Observations
None encountered while drilling

Advancement Method
4-inch diameter solid stem continuous flight power auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig CME-55
Hammer Type Automatic
Driller Terracon
Logged by DR
Boring Started 04-06-2023
Boring Completed 04-06-2023

Facilities | Environmental | **Geotechnical** | Materials

Redundant Surveillance Mission Electrical Power Supply
East Breckenridge Avenue and South Powderhorn Street | Aurora, Colorado
Terracon Project No. 25225138A

Terracon
10625 W 170 Frontage Rd N
Ste 3
Wheat Ridge, CO

Boring Log No. PS-4

Location: See Exploration Plan
Latitude: 39.7145° Longitude: -104.7790°

Depth (Ft.)	Graphic Log	Model Layer	Water Level Observations	Sample Type	Field Test Results	SWELL (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
0		2								
5					6-9	+1.4 @ 200 psf	20.1	107	41-16-25	75
					4-5		20.3	106		
7.0										
		3			5-7		17.7	106		
8.5										
10		4			5-5		14.6	113		
12.0										
15					5-8		10.1	113		
15.0										

FILL - LEAN CLAY (CL), with sand, brown to light brown, medium stiff to stiff

LEAN CLAY (CL), with sand, brown to light brown, stiff

CLAYEY SAND (SC), fine to coarse grained, brown, loose

POORLY GRADED SAND (SP), with silt, fine to coarse grained, tan, loose

Boring Terminated at 15 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes

Water Level Observations
None encountered while drilling

Advancement Method
4-inch diameter solid stem continuous flight power auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig CME-55
Hammer Type Automatic
Driller Terracon
Logged by DR
Boring Started 04-05-2023
Boring Completed 04-05-2023

Facilities | Environmental | **Geotechnical** | Materials

Redundant Surveillance Mission Electrical Power Supply
East Breckenridge Avenue and South Powderhorn Street | Aurora, Colorado
Terracon Project No. 25225138A

Terracon
10625 W 170 Frontage Rd N
Ste 3
Wheat Ridge, CO

Boring Log No. PS-5

Location: See Exploration Plan
Latitude: 39.7150° Longitude: -104.7764°

Depth (Ft.)	Graphic Log	Model Layer	Water Level Observations	Sample Type	Field Test Results	SWELL (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
0		2								
5					8-8		6.0	106	31-14-17	33
					5-6		13.4	96		
6.0										
		3			5-8		19.2	107		
10					7-10		22.1	103		
15					5-9		20.2	104		
15.0										

FILL - CLAYEY SAND (SC), with gravel, fine to medium grained, dark brown, loose to medium dense

varies to sandy lean clay around 4 feet

LEAN CLAY (CL), with sand, brown to light brown, stiff

Boring Terminated at 15 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes

Water Level Observations
None encountered while drilling

Advancement Method
4-inchdiameter solid stem continuous flight power auger

Abandonment Method
Boringbackfilled with auger cuttings upon completion.

Drill Rig CME-55
Hammer Type Automatic
Driller Terracon
Logged by DR
Boring Started 04-06-2023
Boring Completed 04-06-2023

Facilities | Environmental | **Geotechnical** | Materials

Redundant Surveillance Mission Electrical Power Supply
East Breckenridge Avenue and South Powderhorn Street | Aurora, Colorado
Terracon Project No. 25225138A

Terracon
10625 W 170 Frontage Rd N
Ste 3
Wheat Ridge, CO

Boring Log No. PS-6

Location: See Exploration Plan
Latitude: 39.7157° Longitude: -104.7765°

Depth (Ft.)	Graphic Log	Model Layer	Water Level Observations	Sample Type	Field Test Results	SWELL (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
0		1								
0.3		2								
5					6-8		9.9		26-14-12	33
3.5										
		3			5-5		17.1	110		
					7-9		21.0	103		
10					7-10		19.3	106		
12.0										
15					6-7		14.1	115		
15.0										

ASPHALT, about 4 inches

FILL - CLAYEY SAND (SC), fine to medium grained, dark brown, loose

LEAN CLAY (CL), with sand, brown, medium stiff to stiff

SANDY LEAN CLAY (CL), light brown to tan, stiff

Boring Terminated at 15 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
See Supporting Information for explanation of symbols and abbreviations.

Notes

Water Level Observations
None encountered while drilling

Advancement Method
4-inch diameter solid stem continuous flight power auger

Abandonment Method
Boring backfilled with auger cuttings and surface capped with asphalt upon completion.

Drill Rig CME-55
Hammer Type Automatic
Driller Terracon
Logged by DR
Boring Started 04-06-2023
Boring Completed 04-06-2023

Facilities | Environmental | **Geotechnical** | Materials

A9 GEOTECHNICAL BORING LOGS
NTS

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. DOUGHTY
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W912BF24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-2000

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

GEOTECHNICAL BORING LOGS

SHEET ID
VF109

READY-TO-ADVERTISE (RTA) SUBMITTAL

CUI

HIGHWAY 30

BUCKLEY SPACE FORCE BASE CONTRACTOR ENTRANCE, LARGE VEHICLE INSPECTION POINT (LVIP)

WINTER PARK PL.

E. STEAMBOAT AVE.

E. STEAMBOAT AVE.

ASPEN ST.

CONTRACTOR ACCESS ROUTE

POWDER HORN ST.

PL-1 RESTRICTED ACCESS GATE

CONTRACTOR TRAILER AND POV PARKING OUTSIDE OF PL-1 RESTRICTED AREA

PL-1 RESTRICTED AREA

E. BUTTERMILK AVE.

OVERFLOW CONTRACTOR PARKING

CONTRACTOR STAGING AREA OUTSIDE SITE SECURITY FENCE

BRECKENRIDGE AVE.

ASPEN ST.

INSTALLATION ACCESS NOTES:

1. ANY LARGE VEHICLE WITH THREE OR MORE AXLES, OR VEHICLE TOWING A TRAILER, OR VEHICLE WITH AN ENCLOSED BED, MUST USE THE LARGE VEHICLE INSPECTION POINT (LVIP) TO ACCESS THE INSTALLATION.
2. THE LVIP'S HOURS OF OPERATIONS ARE MONDAY-FRIDAY, 0600-1800. AFTER-HOURS DELIVERIES WILL BE PROCESSED BY EXCEPTION ONLY.
3. THE LVIP IS LOCATED OFF 6TH AVENUE, APPROXIMATELY ½ MILE EAST OF THE 6TH AVENUE GATE ENTRANCE (AT 6TH AVE. & ASPEN ST.).
4. IF A CONTRACTOR IS UTILIZING THEIR VEHICLE FOR PERSONAL TRANSPORT ONLY (E.G. SEDANS, SUVs, OPEN BED PICKUP TRUCKS), THEY MAY USE THE NORMAL VEHICLE GATES (6TH AVE GATE OR MISSISSIPPI GATE) FOR INSTALLATION ACCESS.
5. STAGING AREA TO BE COORDINATED WITH THE INSTALLATION.
6. OVERFLOW CONTRACTOR PARKING WILL BE AVAILABLE WEST OF BUILDING 606.

LEGEND

- STAGING AREA
- CONTRACTOR ACCESS ROUTE
- SECURITY FENCE
- CONSTRUCTION FENCE

A9 CONTRACTOR ACCESS AND STAGING
1" = 200'

PLAN NORTH

0 200' 400'
SCALE: 1" = 200'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. BOUVOUNOT
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-422-0600

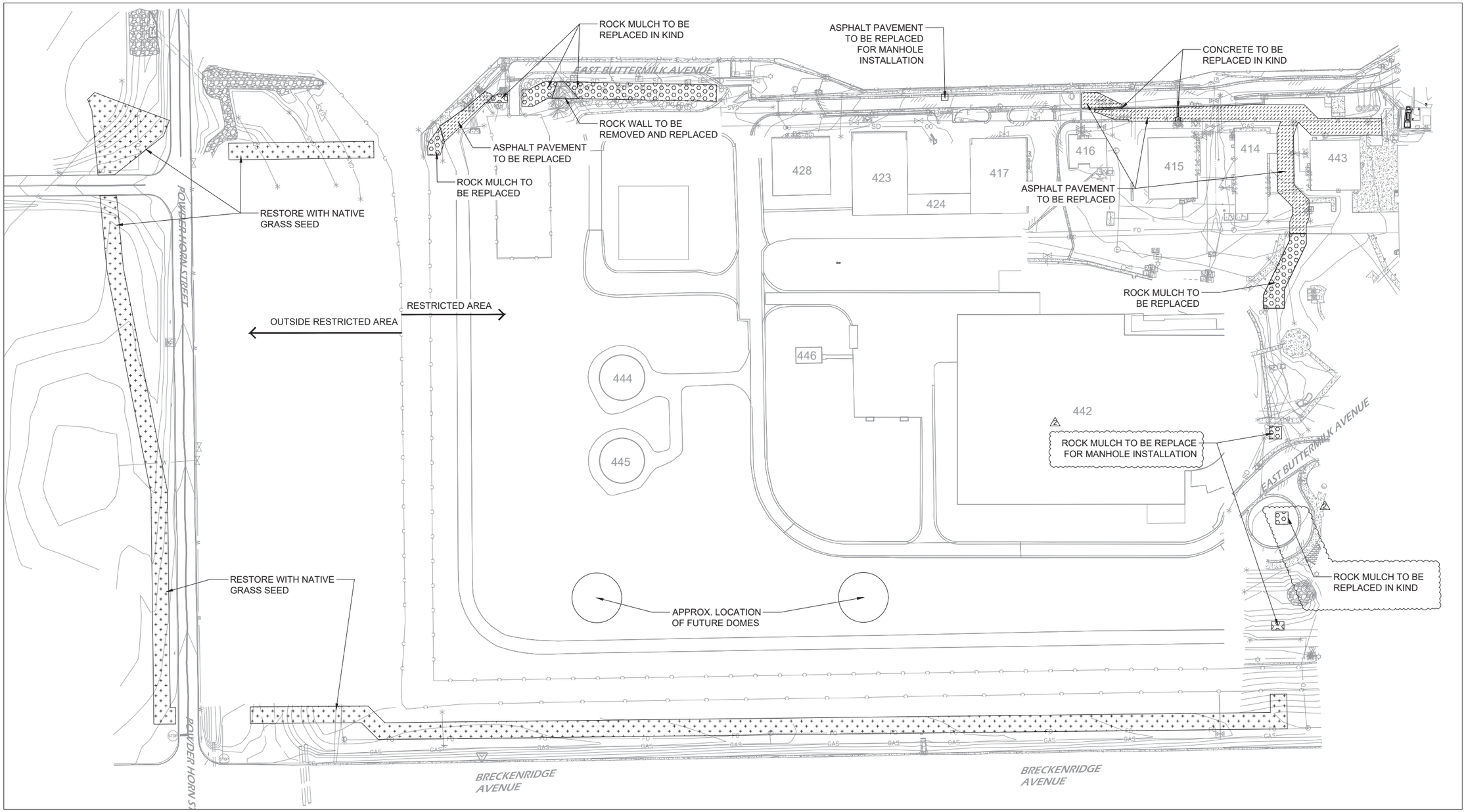
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

CONTRACTOR ACCESS AND STAGING

SHEET ID
CI101

READY-TO-ADVERTISE (RTA) SUBMITTAL

CUI



NOTES:

1. SITE RESTORATION IS TO MATCH EXISTING CONDITIONS.

LEGEND

- ASPHALT PAVEMENT / PATCH
- CONCRETE PAVEMENT / PATCH
- NATIVE SEED
- ROCK MULCH

A11 SITE RESTORATION PLAN
1" = 60'

PLAN NORTH

0 60' 120'
SCALE: 1" = 60'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
2	AMENDMENT 0002	08/09/2024

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. KNEUVOORT
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-2000

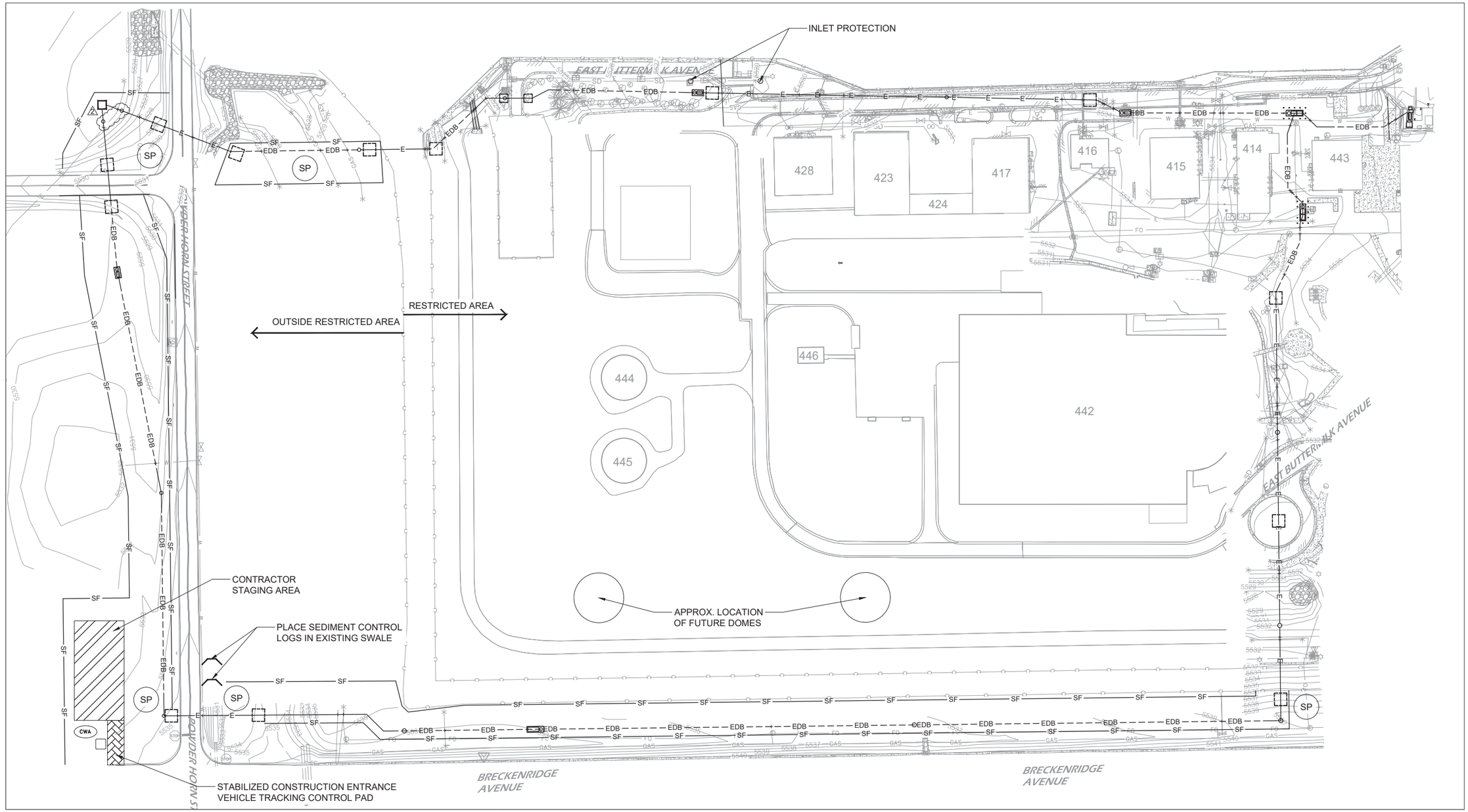
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

SITE RESTORATION PLAN

SHEET ID
CS101

READY-TO-ADVERTISE (RTA) SUBMITTAL

CUI



NOTES:

1. SEE SHEET CG501 FOR EROSION CONTROL DETAILS.
2. CONTRACTOR SHALL INSTALL ADDITIONAL EROSION AND SEDIMENT CONTROL BMPs IN ADDITION TO WHAT IS SHOWN ON THIS PLAN AS NEEDED TO PREVENT SEDIMENT AND DEBRIS FROM ENTERING STREETS AND STORM SEWERS.
3. ALL DISTURBED AREAS SHALL BE RESTORED TO EXISTING CONDITIONS, AND ALL TEMPORARY BMPs SHALL BE REMOVED UPON FINAL GROUND COVER ESTABLISHMENT.
4. APPROXIMATE LOCATION OF CONTRACTOR STAGING AREA SHOWN. FINAL LOCATION MAY CHANGE AS NEEDED BASED UPON SITE CONDITIONS AND CONTRACTIBILITY.
5. ANY SEDIMENT TRACKOUT ONTO IMPERVIOUS SURFACES SUCH AS ROADS, STREETS, AND PAVEMENTS SHALL BE CLEANED UP AT THE END OF EACH WORKING DAY.
6. WITHIN THE RESTRICTED AREA ALL EXCAVATION BY CONTRACTOR TO OCCUR BY HYDRO EXCAVATION. CONTRACTOR TO COORDINATE WITH BASE CE FOR SLURRY SPOIL LOCATION ON BASE.

LEGEND:

- CWA — CONCRETE WASHOUT AREA
- SEDIMENT CONTROL LOG
- SF — SILT FENCE
- SP — STOCK PILE MANAGEMENT
- IP — INLET PROTECTION

A11 EROSION AND SEDIMENT CONTROL PLAN
1" = 60'

PLAN NORTH

0 60' 120'
SCALE: 1" = 60'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0002	08/09/2024

DESIGNED BY:	S. TURNBULL
DRAWN BY:	N. RALEY
CHECKED BY:	K. KRUMWIEDE/T. DOTT
SUBMITTED BY:	YAEGER ARCH
SIZE:	ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-2000

ISSUE DATE:	07/03/2024
SOLICITATION NO.:	W9128F24R0066
CONTRACT NO.:	TBD

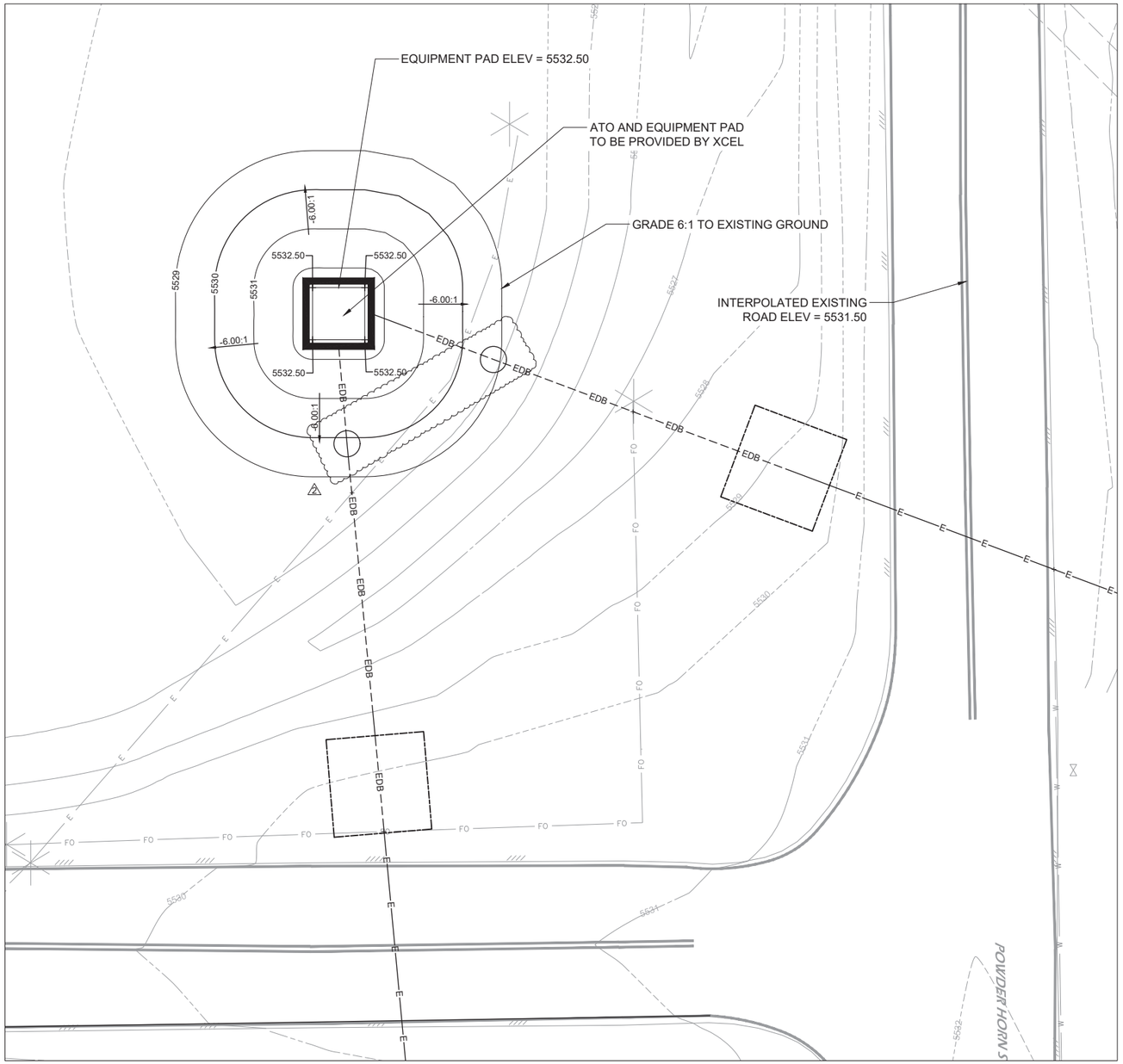
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

EROSION AND SEDIMENT CONTROL PLAN

SHEET ID
CG101

READY-TO-ADVERTISE (RTA) SUBMITTAL

CUI



NOTES:

1. ALL FILL MATERIAL SHALL BE BLADED SMOOTH AND SLOPED TO DRAIN.

LEGEND:

— — — EDB — — —	ELECTRICAL DUCT BANK
——E——E——	ELECTRICAL CONDUIT(S)
ATO	AUTOMATIC THROW OVER
	DIRECTIONAL DRILL END POINT (4)

A11 ATO PAD GRADING PLAN
1" = 60'

PLAN NORTH
0 60' 120'
SCALE: 1" = 60'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
2	AMENDMENT 0004	09/13/2024
1	AMENDMENT 0002	08/09/2024

DESIGNED BY:	ISSUE DATE:
S. TURNBULL	07/03/2024
DRAWN BY:	SOLICITATION NO.:
N. RALEY	W9128F24R0066
CHECKED BY:	CONTRACT NO.:
K. GRIFFITH-WORT	TBD
SUBMITTED BY:	
YAEGER ARCH	
SIZE:	
ANSI D	

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-2000

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004
ATO PAD GRADING PLAN

SHEET ID
CG201

READY-TO-ADVERTISE (RTA) SUBMITTAL

CUI

ATO TO BE PROVIDED BY XCEL REF. SHEET CG201 FOR PAD GRADING AND DETAILS

MH 1-A

DIRECTIONAL DRILL END POINTS 1A AND 1B 2A AND 2B 3A AND 3B

MH 7-A

MH 1

MH 2

MH 3

PRIMARY CABLE ALIGNMENT

DIRECTIONAL DRILL END POINT 4-A

DIRECTIONAL DRILL END PONT 4-B

MH 4

MH 5

MH 6

CONNECT TO B433 VIA EXISTING BKR-CPM THEN EXISTING B433 XFMR

SWGR-ST-R06

SWGR-ST-R05

MH 15

DIRECTIONAL DRILL END POINTS 5A AND 5B

DOUBLE MH VAULT PROVISION FOR FUTURE 4-WAY SWITCHGEAR INSTALLATION

MH 7

CU102

DOUBLE MH VAULT PROVISION FOR FUTURE 4-WAY SWITCHGEAR INSTALLATION

TRIPLE MH VAULT FOR 6-WAY SWITCHGEAR

RESTRICTED AREA

OUTSIDE RESTRICTED AREA

NOT INCLUDED IN SHEET SET - NO SCOPE OF WORK AREA

DIRECTIONAL DRILL END POINT 8-B

CU103

CU104

CU107

MH 8

REDUNDANT POWER FEED ALIGNMENT

MH 14

CONTRACTOR TO STAGE DIRECTIONAL DRILLING IN TRAFFIC CIRCLE AS NECESSARY

DIRECTIONAL DRILL END POINT 7-B / 8-A

APPROX. LOCATION OF FUTURE DOMES

DIRECTIONAL DRILL END POINT 6-A

DIRECTIONAL DRILL END POINT 6-B

CU105

DOUBLE MH VAULT PROVISION FOR FUTURE 4-WAY SWITCHGEAR INSTALLATION

CU106

MH 10

MH 9

MH 11

MH 12

MH 13

MH 13-A

DIRECTIONAL DRILL END POINT 7-A

BRECKENRIDGE AVENUE

EAST JTTERM KAVEN

BOWDER HORN SUMMIT

NOTES:

1. ALL SURFACE CONDITIONS TO BE RESTORED IN KIND AFTER UTILITY PLACEMENT AND BACKFILLING HAS BEEN COMPLETED.
2. CONTRACTOR TO FIELD VERIFY EXISTING CONDITIONS PRIOR TO DRILLING ACTIVITIES AND REPORT ANY DISCREPANCIES TO COR FOR RESOLUTION.
3. DRILL END POINT LOCATIONS AND SIZES ARE APPROXIMATE. CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING EXACT LOCATIONS AND ALL COSTS IN BID FOR INSTALLATION BY TRENCHLESS MEANS.
4. CONTRACTOR MAY ELECT TO INSTALL DUCTBANK BY TRENCHLESS MEANS WITH APPROVAL FROM COR AT NO ADDITIONAL COST TO THE OWNER.
5. WITHIN THE RESTRICTED AREA ALL SURFACE EXCAVATION BY CONTRACTOR TO OCCUR BY HYDRO EXCAVATION. CONTRACTOR TO COORDINATE WITH COR FOR SLURRY SPOIL LOCATION ON BASE.

6. REFER TO DETAIL H1 ON SHEET E-501 FOR CASING DETAIL

LEGEND:

- MANHOLE (MH)
- SPECIAL MANHOLE VAULT WITH PROVISIONS FOR 4 WAY SWITCHGEAR OR FUTURE SWITCHGEAR
- SPECIAL MANHOLE VAULT WITH PROVISIONS FOR 6 WAY SWITCHGEAR OR FUTURE SWITCHGEAR
- EDB — ELECTRICAL DUCT BANK
- E — E — ELECTRICAL CONDUIT(S)
- ATO — AUTOMATIC THROW OVER
- DIRECTIONAL DRILL END POINT

A11 OVERALL UTILITY PLAN
1" = 60'

PLAN NORTH

SCALE: 1" = 60' 0 60' 120'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0004	09/13/2024
2	AMENDMENT 0002	08/09/2024

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. MCCONNAUGHEY
SUBMITTED BY: YAEGER ARCH
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-3000

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

OVERALL UTILITY PLAN

SHEET ID
CU101

READY-TO-ADVERTISE (RTA) SUBMITTAL

CUI

ATO TO BE PROVIDED BY XCEL.

MH 1-A

DIRECTIONAL DRILL END POINT 1-A

DIRECTIONAL DRILL END POINT 1-B

DIRECTIONAL DRILL END POINT 2-A

DIRECTIONAL DRILL END POINT 2-B

MH 1

DIRECTIONAL DRILL END POINT 3-B

DIRECTIONAL DRILL END POINT 3-A

MH 2

MH 3

DOUBLE MANHOLE VAULT PROVISION FOR FUTURE 4-WAY SWITCHGEAR INSTALLATION

DIRECTIONAL DRILL END POINT 4-A

RESTRICTED AREA

OUTSIDE RESTRICTED AREA

FOR CONTINUATION SEE SHEET CU103

FOR CONTINUATION SEE SHEET CU104

LEGEND:

- MANHOLE (MH)
- MANHOLE VAULT, PROVISIONS FOR 4 WAY SWITCHGEAR
- MANHOLE VAULT, PROVISIONS FOR 6 WAY SWITCHGEAR
- EDB — ELECTRICAL DUCT BANK
- E — E — ELECTRICAL CONDUIT(S)
- ATO — AUTOMATIC THROW OVER
- DIRECTIONAL DRILL END POINT

CU102 CU103 CU104 CU105 CU106 CU107

NO SCOPE OF WORK AREA

KEY MAP

CONC. ENCASED ELEC. STA. 0+14.88 TOP EL. 5525.25

MANHOLE MH 1-A STA. 0+20.00

1/4" COMM. LINE STA. 0+42.82 TOP EL. 5523.39

WATERLINE STA. 1+11.74 TOP EL. 5524.52

DIRECT BURIED COMM. STA. 1+97.18 NOT FOUND

GAS LINE STA. 2+68.39 NOT FOUND

GAS LINE STA. 3+00.65 TOP EL. 5528.33

MANHOLE MH1 STA. 3+15.00

OUTER SECURE FENCE STA. 1+41.35

INNER SECURE FENCE STA. 1+41.35

CONC. ENCASED ELEC. STA. 4+06.58 TOP EL. 5522.23

SANITARY STA. 4+23.48 NOT FOUND UP TO 10'

18" RCP STA. 4+68.25 TOP EL. 5522.44

18" RCP STA. 4+71.74 TOP EL. 5522.43

MANHOLE MH2 STA. 5+15.00

18" RCP STA. 4+74.76 TOP EL. 5522.33

CONC. ENCASED ELEC. STA. 4+76.38 TOP EL. 5521.27

COMM. STA. 6+00.23 DEPTH UNKNOWN

DOUBLE MH VAULT, MH3 W/ SWGR. STA. 7+50.00

8" WATERLINE STA. 7+79.23 TOP EL. 5524.13

COMM. STA. 8+13.68 TOP EL. 5526.65

DIRECTIONAL DRILL END POINT 1-A STA. 0+75.00

DIRECTIONAL DRILL END POINT 1-B STA. 1+60.00

85.00' L.F. ELECTRICAL CASING

GAS NOT LOCATED ESTIMATED AT DEPTH OF 3'-3"

COMM. NOT LOCATED ESTIMATED AT DEPTH OF 3'-0"

DIRECTIONAL DRILL END POINT 2-A STA. 3+35.00

DIRECTIONAL DRILL END POINT 2-B STA. 4+00.00

65.00' L.F. ELECTRICAL CASING

SANITARY NOT LOCATED ESTIMATED AT DEPTH OF 8'-0"

DIRECTIONAL DRILL END POINT 3-A STA. 5+18.75

DIRECTIONAL DRILL END POINT 3-B STA. 5+38.00

19.25' L.F. ELECTRICAL CASING

COMM. NOT LOCATED ESTIMATED AT DEPTH OF 3'-0"

DIRECTIONAL DRILL END POINT 4-A STA. 7+75.00

440.25 L.F. ELECTRICAL CASING

5540 5535 5530 5525 5520 5515 5510

0+00 0+50 1+00 1+50 2+00 2+50 3+00 3+50 4+00 4+50 5+00 5+50 6+00 6+50 7+00 7+50 8+00 8+50

A9 PRIMARY CABLE ALIGNMENT PLAN AND PROFILE 1

1" = 30'

PLAN NORTH

SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0004	09/13/2024
2	AMENDMENT 0002	08/09/2024

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. CHRISTENSEN
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-8000

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

PRIMARY CABLE ALIGNMENT PLAN AND PROFILE 1

SHEET ID

CU102

READY-TO-ADVERTISE (RTA) SUBMITTAL

FOR CONTINUATION SEE SHEET CU102

PRIMARY CABLE ALIGNMENT

DOUBLE MANHOLE VAULT PROVISION FOR FUTURE 4-WAY SWITCHGEAR INSTALLATION

TRIPLE MANHOLE VAULT FOR 6-WAY SWITCHGEAR

CONNECT TO B433 VIA EXISTING BKR-CPM THEN B433 EXISTING XFMR REFERENCE ES102 FOR CONTINUATION

SWGR-ST-R06

MH 4

MH 5

MH 6

MH 15

SWGR-ST-R05

DIRECTIONAL DRILL END PONT 4-A

DIRECTIONAL DRILL END POINT 4-B

6"Ø CONCRETE FILLED BOLLARDS

416

415

414

443

CU102

CU103

CU104

CU105

CU106

CU107

NO SCOPE OF WORK AREA

KEY MAP

LEGEND:

- MANHOLE (MH)
- MANHOLE VAULT, PROVISIONS FOR 4 WAY SWITCHGEAR
- MANHOLE VAULT, PROVISIONS FOR 6 WAY SWITCHGEAR
- EDB — ELECTRICAL DUCT BANK
- E — ELECTRICAL CONDUIT(S)
- ATO — AUTOMATIC THROW OVER
- 4 DIRECTIONAL DRILL END POINT

FOR CONTINUATION SEE SHEET CU107

4

12" PVC ELECTRIC STA, 8+72.22 TOP EL. 5523.42
CONC. ENCASED ELEC. STA, 8+86.66, ASSUMED 12" DUCT
CONC. ENCASED ELEC. STA, 8+97.42 ASSUMED 12" DUCT
SANITARY STA, 9+25.92 TOP EL. 5523.42
MANHOLE MH4 STA, 10+50.00
8" PVC GAS LINE STA, 11+88.91 TOP EL. 5531.32
CONC. ENCASED ELEC. STA, 12+13.69 TOP EL. 5533.77
1 1/2" STEEL GAS LINE STA, 12+39.21 TOP EL. 5531.48
CONC. ENCASED ELEC. STA, 12+41.13 TOP EL. 5531.97
CONC. ENCASED ELEC. STA, 12+53.06 ASSUMED 12" DUCT
CONC. ENCASED ELEC. STA, 12+53.29 TOP EL. 5531.89
DOUBLE MH VAULT, MH5 W/ SWGR, STA, 12+69.00
CONC. ENCASED ELEC. STA, 12+78.47 TOP EL. 5534.45
CONC. ENCASED ELEC. STA, 12+83.33 TOP EL. 5532.84
CONC. ENCASED ELEC. STA, 13+34.56 ASSUMED 12" DUCT
8" STEEL GAS LINE STA, 13+75.71 TOP EL. 5532.06
CONC. ENCASED ELEC. STA, 13+83.63 TOP EL. 5533.94
SANITARY STA, 13+86.88 TOP EL. 5526.89
TRIPLE MH VAULT, MH6 W/ SWGR, STA, 14+75.75
8" PVC WATERLINE STA, 14+95.27 TOP EL. 5530.40
12" PVC STORM SEWER STA, 15+94.18 TOP EL. 5533.71
EX. ELECTRIC STA, 16+04.14 TOP EL. 5532.43
CONNECT TO EX. BREAKER

5550 5545 5540 5535 5530 5525 5520

8+50 9+00 9+50 10+00 10+50 11+00 11+50 12+00 12+50 13+00 13+50 14+00 14+50 15+00 15+50 16+00 16+50

EDB

SANITARY NOT LOCATED ESTIMATED AT DEPTH OF 8'-0"

440.25 L.F. ELECTRICAL CASING

DIRECTIONAL DRILL END POINT 4-B STA, 12+15.25

REDUNDANT POWER REFERENCE SHEET CU107

ELECTRIC NOT LOCATED ESTIMATED AT DEPTH OF 3'-0"

PLAN NORTH

0 30' 60'

SCALE: 1" = 30'

A9 PRIMARY CABLE ALIGNMENT PLAN AND PROFILE 2

1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
4	AMENDMENT 0004	09/13/2024

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. MCCLOSKEY
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-0300

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

PRIMARY CABLE ALIGNMENT PLAN AND PROFILE 2

SHEET ID
CU103

READY-TO-ADVERTISE (RTA) SUBMITTAL

FOR CONTINUATION SEE SHEET CU102

FOR CONTINUATION SEE SHEET CU105

PRIMARY CABLE ALIGNMENT
SEE SHEET CU102

REDUNDANT POWER FEED

MH 8

MH 7

MH 7-A

MH 9

DIRECTIONAL DRILL END POINT 6-A

DOUBLE MANHOLE VAULT PROVISION FOR FUTURE 4-WAY SWITCHGEAR INSTALLATION

DIRECTIONAL DRILL END POINT 5-B

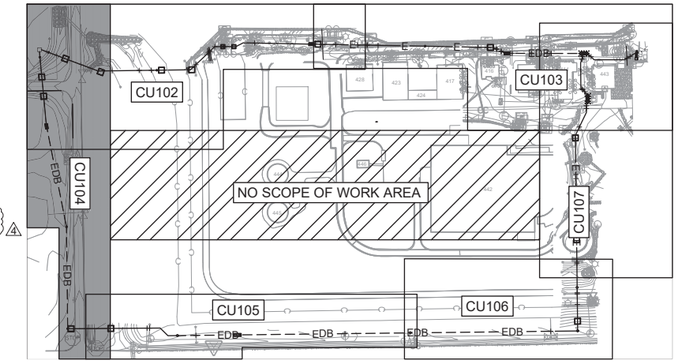
DIRECTIONAL DRILL END POINT 5-A

ATO TO BE PROVIDED BY XECL

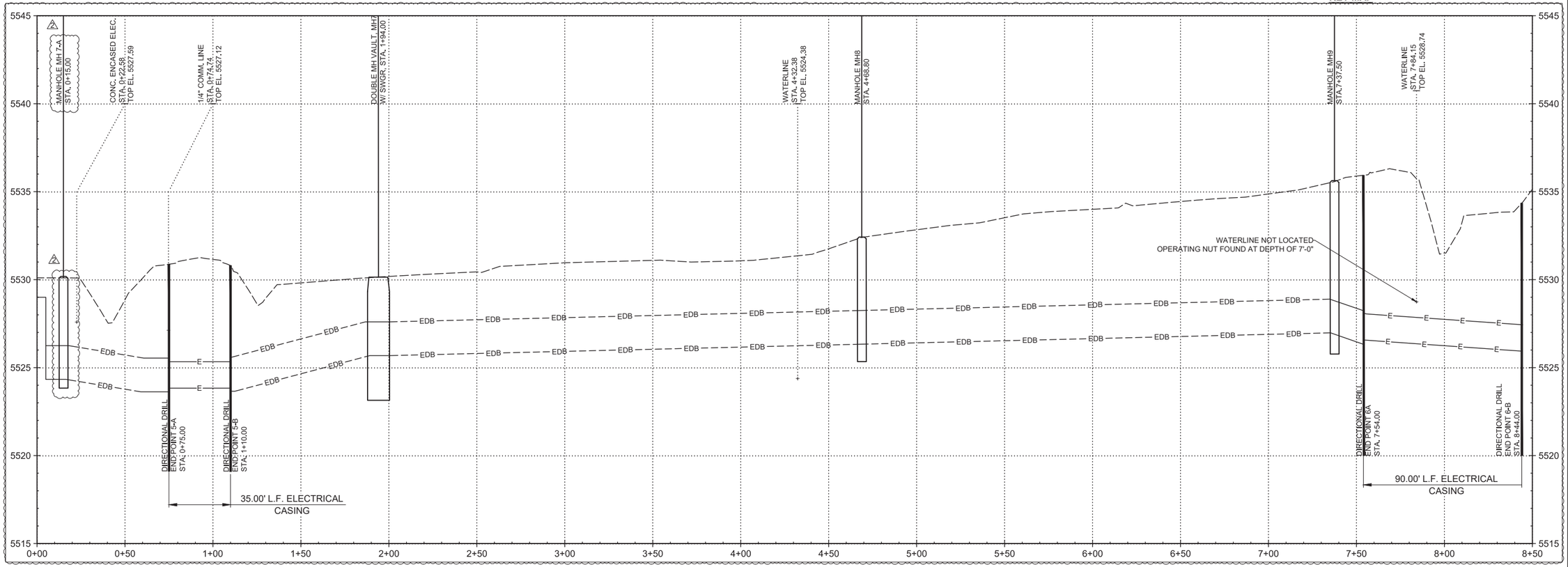
0+00 1+00 2+00 3+00 4+00 5+00 6+00 7+00 8+00

LEGEND:

- MANHOLE (MH)
- MANHOLE VAULT, PROVISIONS FOR 4 WAY SWITCHGEAR
- MANHOLE VAULT, PROVISIONS FOR 6 WAY SWITCHGEAR
- EDB — ELECTRICAL DUCT BANK
- E — E — ELECTRICAL CONDUIT(S)
- ATO — AUTOMATIC THROW OVER
- DIRECTIONAL DRILL END POINT



KEY MAP



A9 REDUNDANT POWER FEED PLAN AND PROFILE 1
1" = 30'

PLAN NORTH

0 30' 60'
SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
4	AMENDMENT 0004	09/13/2024
2	AMENDMENT 0002	08/09/2024

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. MCCOMPORT
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-8000

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

REDUNDANT POWER FEED PLAN AND PROFILE 1

SHEET ID
CU104

READY-TO-ADVERTISE (RTA) SUBMITTAL

CAUTION!!
GAS LINES AND FIBER OPTIC

DOUBLE MANHOLE VAULT PROVISION FOR FUTURE 4-WAY SWITCHGEAR INSTALLATION

RESTRICTED AREA

OUTSIDE RESTRICTED AREA

MH 10

MH 11

MH 12

DIRECTIONAL DRILLING END POINT 6-B

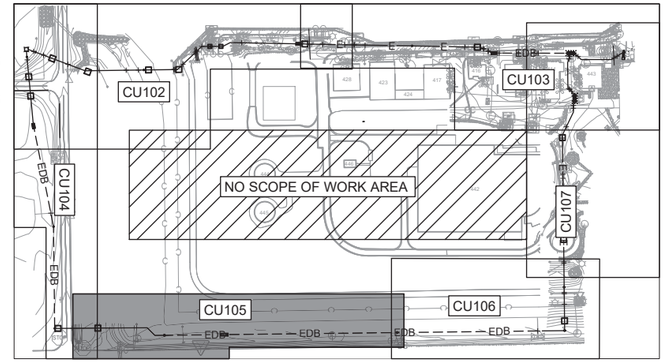
BRECKENRIDGE AVENUE

FOR CONTINUATION SEE SHEET CU104

FOR CONTINUATION SEE SHEET CU106

LEGEND:

- MANHOLE (MH)
- MANHOLE VAULT, PROVISIONS FOR 4 WAY SWITCHGEAR
- MANHOLE VAULT, PROVISIONS FOR 6 WAY SWITCHGEAR
- EDB — ELECTRICAL DUCT BANK
- E — E — ELECTRICAL CONDUIT(S)
- ATO — AUTOMATIC THROW OVER
- DIRECTIONAL DRILLING END POINT 4



KEY MAP

GAS LINE
STA. 9+46.94
NOT FOUND UP TO 5'

CONC. ENCASED COMM.
STA. 9+53.67
TOP EL. 5534.10

6" STEEL GAS LINE
STA. 9+53.78
TOP EL. 5533.60

MANHOLE MH10
STA. 10+35.00

12" CLAY SANITARY
STA. 10+84.11
TOP EL. 5529.80

DOUBLE MH VAULT, MH11
W/ SWGR, STA. 12+00.00

GAS LINE
STA. 14+77.59
NOT FOUND UP TO 5'

MANHOLE MH12
STA. 16+50.00

GAS LINE NOT LOCATED
ESTIMATED AT DEPTH OF 3'-3"

GAS LINE NOT LOCATED
ESTIMATED AT DEPTH OF 3'-3"

DIRECTIONAL DRILL
END POINT 6-B
STA. 8+44.00

90.00' L.F. ELECTRICAL CASING

8+00 8+50 9+00 9+50 10+00 10+50 11+00 11+50 12+00 12+50 13+00 13+50 14+00 14+50 15+00 15+50 16+00 16+50

5550 5545 5540 5535 5530 5525 5520

A9 REDUNDANT POWER FEED PLAN AND PROFILE 2
1" = 30'

PLAN NORTH

0 30' 60'
SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
4	AMENDMENT 0004	09/13/2024

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. BRUCKNER-GOFF
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-814-20300

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

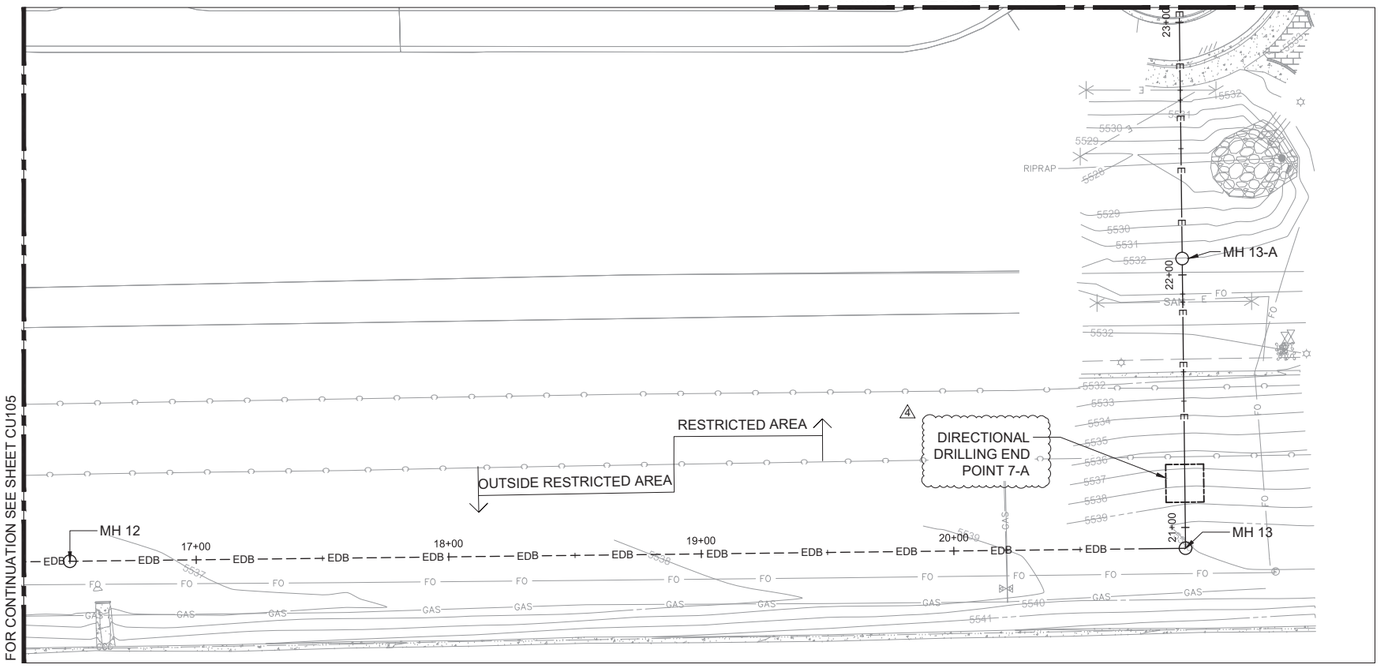
REDUNDANT POWER FEED PLAN AND PROFILE 2

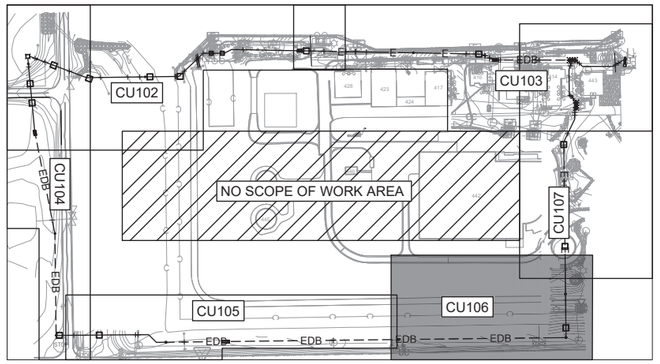
SHEET ID
CU105

READY-TO-ADVERTISE (RTA) SUBMITTAL

FOR CONTINUATION SEE SHEET CU107

FOR CONTINUATION SEE SHEET CU105



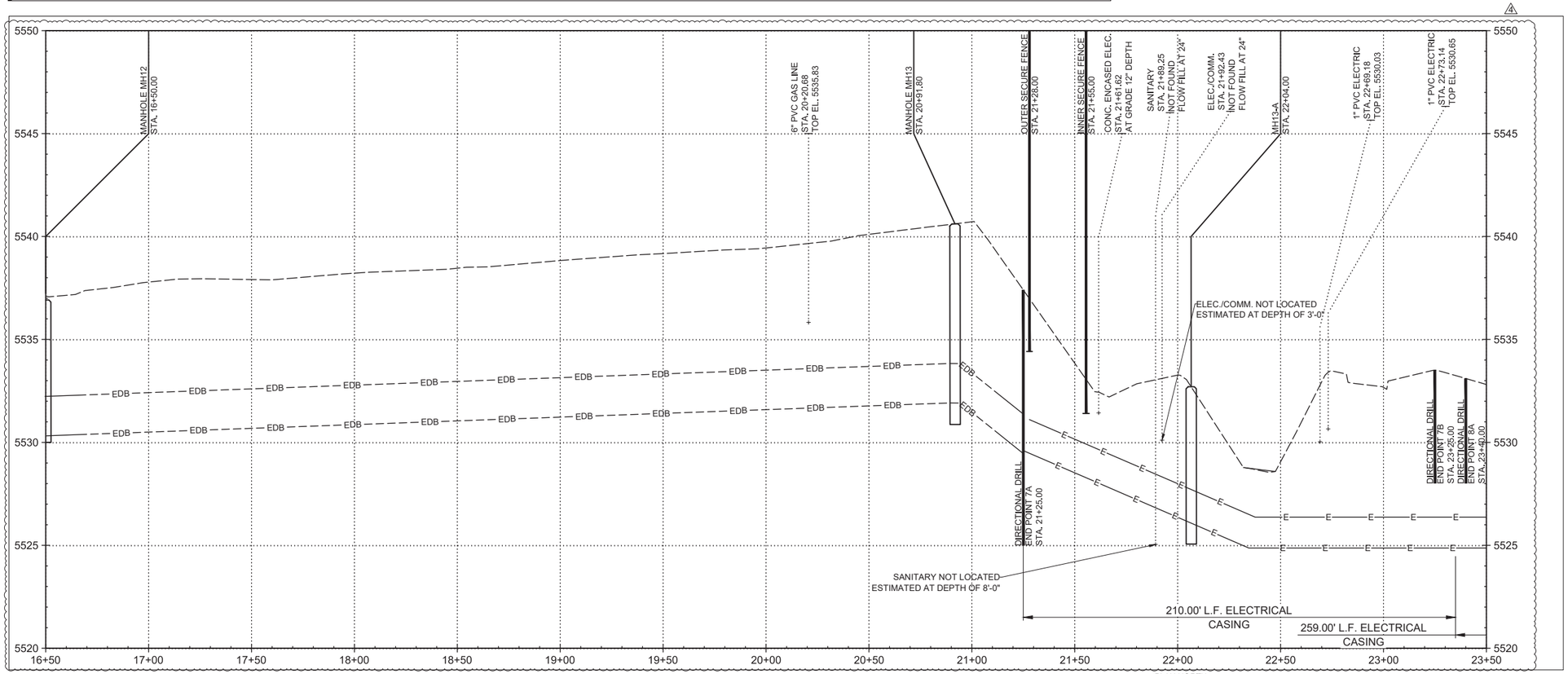


KEY MAP

LEGEND:

- MANHOLE (MH)
- MANHOLE VAULT, PROVISIONS FOR 4 WAY SWITCHGEAR
- MANHOLE VAULT, PROVISIONS FOR 6 WAY SWITCHGEAR
- EDB — ELECTRICAL DUCT BANK
- E — ELECTRICAL CONDUIT(S)
- ATO — AUTOMATIC THROW OVER
- DIRECTIONAL DRILLING END POINT ⚠4

⚠4



A9 REDUNDANT POWER FEED PLAN AND PROFILE 3

1" = 30'

PLAN NORTH

0 30' 60'

SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
1	AMENDMENT 0004	09/13/2024

DESIGNED BY:	S. TURNBULL
DRAWN BY:	N. RALEY
CHECKED BY:	K. BULLOCK
SUBMITTED BY:	YAEGER ARCH
SIZE:	ANSI D
ISSUE DATE:	07/03/2024
SOLICITATION NO.:	W9128F24R0066
CONTRACT NO.:	TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
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YAEGER ARCHITECTURE
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913-422-8000

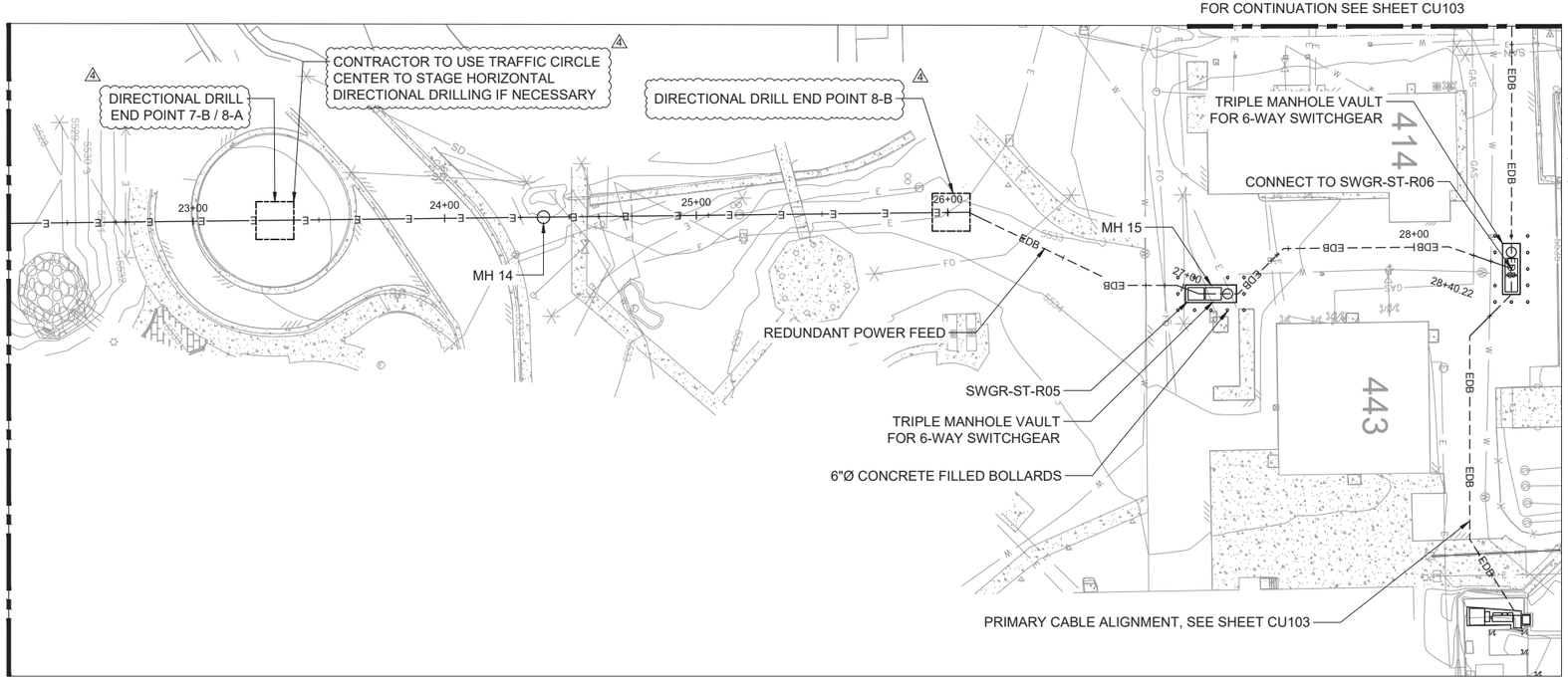
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

REDUNDANT POWER FEED PLAN AND PROFILE 3

SHEET ID

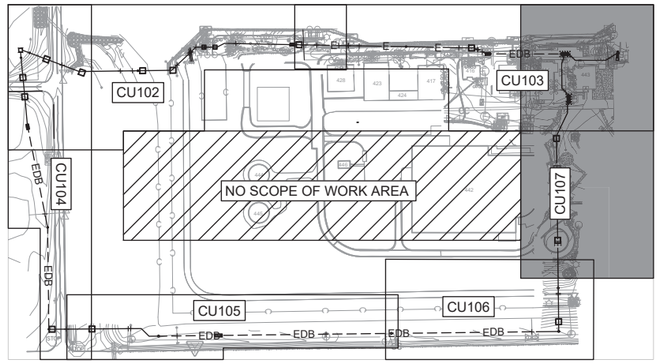
CU106

READY-TO-ADVERTISE (RTA) SUBMITTAL

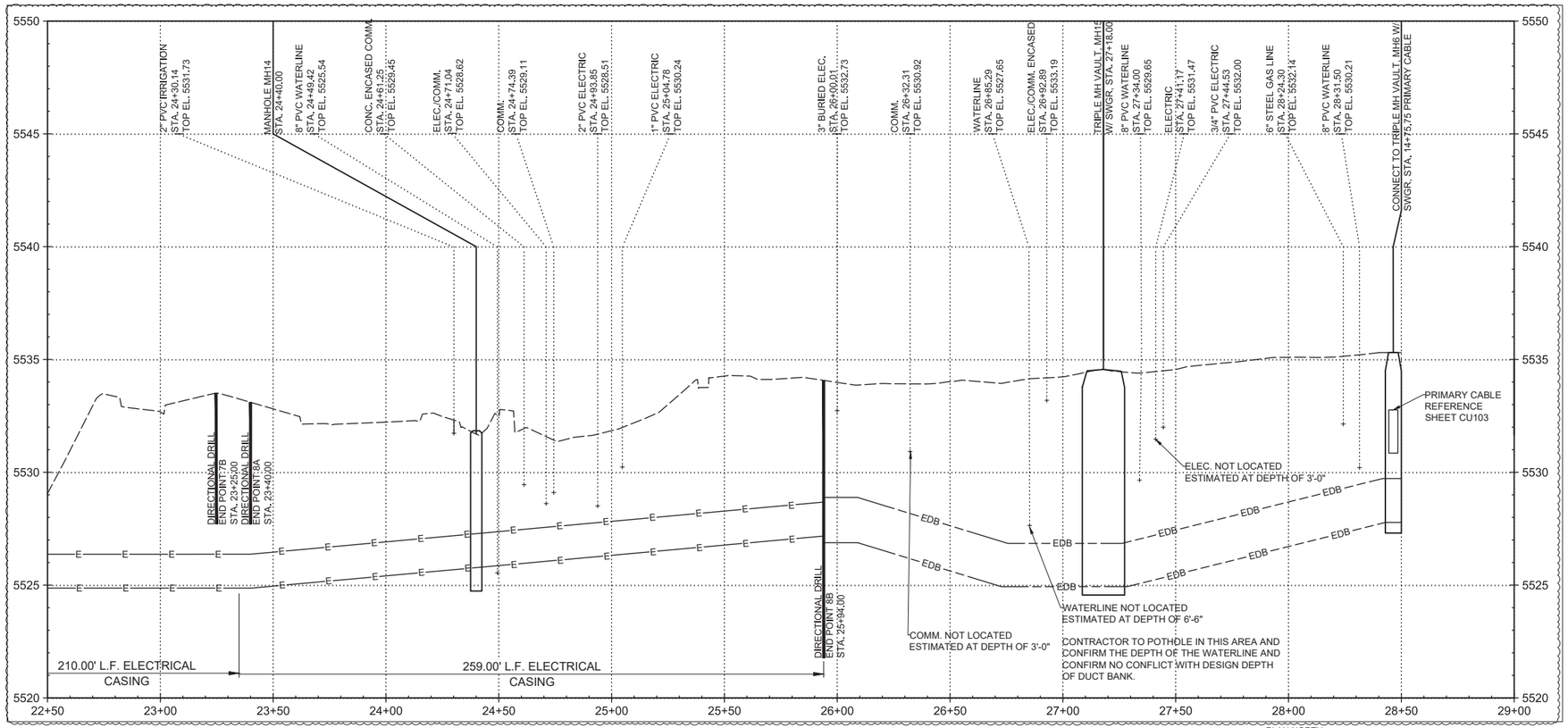


LEGEND:

- MANHOLE (MH)
- MANHOLE VAULT, PROVISIONS FOR 4 WAY SWITCHGEAR
- MANHOLE VAULT, PROVISIONS FOR 6 WAY SWITCHGEAR
- EDB — ELECTRICAL DUCT BANK
- E — ELECTRICAL CONDUIT(S)
- ATO — AUTOMATIC THROW OVER
- DIRECTIONAL DRILL END POINT (4)



KEY MAP



A9 REDUNDANT POWER FEED PLAN AND PROFILE 4
1" = 30'

PLAN NORTH
0 30' 60'
SCALE: 1" = 30'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
4	AMENDMENT 0004	09/13/2024

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W912BF24R0066
CONTRACT NO.: TBD

DESIGNED BY: S. TURNBULL
DRAWN BY: N. RALEY
CHECKED BY: K. MCDERMOTT
SUBMITTED BY: YAEGER ARCH
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
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LENEXA, KS 66219
913-814-9000

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

REDUNDANT POWER FEED PLAN AND PROFILE 4

SHEET ID
CU107

READY-TO-ADVERTISE (RTA) SUBMITTAL

A	AMPERES
AF	AMP FRAME
AFF	ABOVE FINISH FLOOR
AFG	ABOVE FINISH GRADE
AIC	AMPERE INTERRUPTING CAPACITY
A/M	AUTO/MANUAL SWITCH
AM	AMMETER
AMC	AUTO-MANUAL CONTROL
AMP	AMPERE
AMRS	ADVANCE METER READING SYSTEMS
APPROX	APPROXIMATELY
AWG	AMERICAN WIRE GAUGE
AUX	AUXILIARY
BATT	BATTERY
BDA	BUS DIFFERENTIAL A
BDB	BUS DIFFERENTIAL B
BET	BUILDING ENTRANCE TERMINAL
BF	BREAKER FAILURE
BFI	BREAKER FAILURE INITIATE
BK	BLACK
BKR	BREAKER
BL	BLUE
BLDG	BUILDING
BLK	BLACK
BMLS	BMS LAN SWITCH
BMS	BUILDING MANAGEMENT SYSTEM
BN	BROWN
C	CLOSE, CONDUIT
CAB	CABINET
CB	CIRCUIT BREAKER
CBC	CIRCUIT BREAKER CLOSE CIRCUIT
CBT	CIRCUIT BREAKER TRIP CIRCUIT
CBM	CIRCUIT BREAKER METER CIRCUIT
CKT	CIRCUIT
CL	CLASS
CONN	CONNECTED OR CONNECTION
CP	CONTROL PANEL
CPT	CONTROL POWER TRANSFORMER
CPTR	CONTROL POWER TRANSFORMER RELAY
CS	CIRCUIT BREAKER CONTROL SWITCH/CONTROL
CT	STATION CURRENT TRANSFORMER
CTB	CURRENT TEST BLOCK
CTL	CONTROL
CU	COPPER
CV	CABLE VAULT
DA	DIGITAL AMMETER
DB	DIRECT BURIED
DC	DIRECT CURRENT/DC PANEL BOARD
DCP	DOOR CONTROL PANEL, DIRECT CURRENT PANELBOARD
DCS	DIGITAL CONTROL SYSTEM
DDC	DIRECT DIGITAL CONTROL
DEM	DEMAND
DIB	DEVICE INTERFACE BOX
DIST	DISTANCE
DMM	DIGITAL MULTIMETER (AMPS, VOLTS, FREQUENCY, WATTS, VARS, WATTHOURS, VARHOURS, POWER FACTOR)
DP	DISTRIBUTION PANEL (POWER)
DS	DISCONNECT SWITCH
DSLC	DIGITAL SYNCHRONIZER LOAD CONTROL
DVR	VOLTAGE REGULATOR

E	EAST
EF	EXPANSION FITTING
EDB	ELECTRIC DUCT BANK
EHH	ELECTRICAL HANDHOLE
ELEC	ELECTRICAL
ELECT	ELECTRICAL
ELEV	ELEVATION
ELN	EXECUTION LEVEL NODE
EMCP	ENGINE MONITORING AND CONTROL PANEL
EMCS	ENERGY MONITORING AND CONTROL SYSTEM
EMH	ELECTRICAL MANHOLE
EMI	ELECTROMAGNETIC INTERFERENCE
EMS	ENERGY MANAGEMENT SYSTEM
ENCL	ENCLOSURE
EQ	EQUAL
EQUIP	EQUIPMENT
ESA	ELECTRICAL SURGE ARRESTER
EST	ESTIMATED
ETM	ELAPSED TIME METER
ETU	ELECTRONIC TRIP UNIT
(F)	FUTURE
FM	FREQUENCY METER
GAL	GALVANIZED
G,GN	GREEN,GROUND
GB	GROUND BAR
GW	GROUNDING WELL
H	HIGH OR HANDHOLE OR HOUSE POWER
HOA	HAND-OFF-AUTO SWITHC
HP	HORSEPOWER
HS	HAND SWITCH
HZ	HERTZ
IND	INDICATION
INSTR	INSTRUMENT
IS	INTEGRATED SWITCHBOARD
JB	JUNCTION BOX
KAIC	KILOVOLT-AMPERES INTERRUPTING CAPACITY
KV	KILOVOLTS
KVA	KILOVOLT AMPERES
KVAR	KILOVAR
KVH	KILOVARHOUR
KW	KILOWATTS
KWH	KILOWATTHOUR
L	LOCAL
LB	LOAD BANK
LBS	POUNDS

LOR	LOCKOUT RELAY
L/R	LOCAL/REMOTE SWITCH
LTC	LOAD TAP CHANGER
LTS	LIGHTS
LV	LOW VOLTAGE (600V OR LESS)
MAG	ELECTROMAGNETIC LOCK
MBS	MAINTENANCE BYPASS SWITCHGEAR
MBP	MANUAL BYPASS
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MCGB	MAIN COMMUNICATIONS GROUND BAR
MCOV	MAXIMUM CONTINUOUS OPERATING VOLTAGE
MCP	MOTOR CIRCUIT PROTECTOR
MCS	MAIN CIRCUIT SWITCH
MDP	MAIN DISTRIBUTION PANEL
MECH	MECHANICAL
MGB	MAIN GROUND BAR
MH	MANHOLE
ML	MORTISE LOCK
MLO	MAIN LUGS ONLY
MN	MAIN
MOG	MOTOR OPERATED GATE
MOV	METAL OXIDE VARISTOR
MPZ	MINI POWER ZONE
MR	MULTIPLE-RATIO
MS	MOTOR STARTER, MOTION SENSOR
MSB	MAIN SWITCHBOARD
MTL	METAL
MTR	METER, MOTOR
MTS	MANUAL TRANSFER SWITCH OR METER TEST SWITCH
MV	MEDIUM VOLTAGE
MVA	MEGAVOLT-AMPERES
MVS	MEDIUM VOLTAGE SWITCHGEAR
N/A	NOT APPLICABLE
NC	NORMALLY CLOSED
NE	NORTHEAST
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NIC	NOT IN CONTRACT
NIU	NETWORK INTERFACE UNIT
NLTC	NO LOAD TAP CHANGER
NM	NANOMETERS
NO	NUMBER, NORMALLY OPEN
NRTL	NATIONALLY RECOGNIZED TESTING LABORATORY
NSW	NETWORK SWITCH
NTS	NOT TO SCALE
NW	NORTHWEST
O	ORANGE
O/C	OVERCURRENT
OLTC	ON LOAD TAP CHANGER
OL	OVERLOAD
P	POLE
PS	POWER SUPPLY
PB	PULLBOX
PDM	POWER DISTRIBUTION MODULE
PF	POWER FACTOR
PGB	POWER GROUND BAR
PP	POWER PLAN, POWER PANEL
PQM	POWER QUALITY METER
PQMS	POWER QUALITY MONITORING SYSTEM
PR	PAIR/POWER RECEPTACLE (480V)
PST	PHASE SHIFTING TRANSFORMER
PT	POTENTIAL TRANSFORMER
PTB	POTENTIAL TEST BLOCK
PVC	POLYVINYL CHLORIDE CONDUIT

PVT	POTENTIAL VOTAGE TRANSFORMER
PWR	POWER
QTY	QUANTITY
R	REMOTE
RF	RADIO FREQUENCY
RL	REMOTE/LOCAL
RM	ROOM
RMC	RIGID METAL CONDUIT
S	SLIP FITTING, SOUTH
SA	SURGE ARRESTER
SB	SWITCHBOARD
SE	SOUTHEAST
SEC	SECONDS
SEL	SCHWEITZER ENGINEERING LABORATORIES
SH	SYSTEM SHEET
SLD	SINGLE LINE DIAGRAM
SOO	SEQUENCE OF OPERATION
SPD	SURGE PROTECTION DEVICE
SQ	SQUARE
SS	STAINLESS STEEL OR SYNCHRONIZING SWITCH
SSDA	SURGE SUPPRESSION DATA
SSR	SOLID STATE REGULATOR
STB	SHORTENING TERMINAL BLOCK
STC	SOUND TRANSMISSION CLASS
STD	STANDARD
STHWEST	SOUTHWEST
STOR	STORAGE
SUB	SUBSTATION
SUPV	SUPERVISORY
SUS	SECONDARY UNIT SUBSTATION
SW	SWITCH OR SOFTWARE (VALUE GENERATED INTERNALLY)
SWBD	SWITCHBOARD
SWGR (SWG)	SWITCHGEAR
TB	TERMINAL BLOCK
TBD	TO BE DETERMINED
TH	TRANSFORMER HIGH-SIDE
THD	TOTAL HARMONIC DISTORTION
THWN	THERMOPLASTIC HEAT AND WATER RESISTANT NYLON COATED
TL	TRANSFORMER LOW-SIDE
TMDE	TEST MEASUREMENT AND DIAGONSTIC EQUIPMENT
TOC	TRUCK OPERATED CONTACT
TOT	TOTAL
TP	TRANSFORMER PRIMARY
TR	TRANSFORMER
TS	TEMPERATURE SWITCH, TEST SWITCH
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
TYP	TYPICAL
UL	UNDERWRITERS LABORATORIES
UNO	UNLESS NOTED OTHERWISE
V	VOLTAGE
VAC	AC VOLTS
VAR	VOLT AMPERE REACTIVE
VARH	VARHOUR
VDC	VOLTS DIRECT CURRENT
W	WHITE, WIRE, WIDTH, WEST
W/	WITH
WHD	WATT HOUR DEMAND
WP	WEATHERPROOF
XFMR	TRANSFORMER
XFR	TRANSFER
Y	YELLOW

GENERAL NOTES:

1. THE ELECTRICAL DRAWINGS ARE DIAGRAMMATIC AND INDICATE THE GENERAL LOCATION OF DEVICES, EQUIPMENT, AND THE ARRANGEMENT OF THE CIRCUITRY. THE DRAWINGS DO NOT SHOW EVERY NECESSARY OFFSET, BEND, PULL BOX OR OBSTRUCTION. DO NOT SCALE DRAWINGS.
2. NOT ALL SYMBOLS AND ABBREVIATIONS ARE USED.

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

DESIGNED BY: K.MANNING
DRAWN BY: J. WITHROW
CHECKED BY: M. KNEEBONE
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE.
OVERLAND PARK, KS 66211

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ELECTRICAL ABBREVIATIONS

SHEET ID
E-001

READY-TO-ADVERTISE (RTA) SUBMITTAL

ONE-LINE

- 100kVA 480V 208/120V — POWER TRANSFORMER WITH DELTA CONNECTED PRIMARY AND GROUNDED WYE CONNECTED SECONDARY
- 52 — ELECTRICALLY OPERABLE DRAWOUT VACUUM CIRCUIT BREAKER
- DRAWOUT HIGH VOLTAGE FUSE AND POTENTIAL TRANSFORMERS
- CONNECTION
- GROUNDING RESISTOR
- 800A — ELECTRICALLY OPERABLE METAL-ENCLOSED DIELECTRIC FAULT INTERRUPTING SWITCH MEDIUM VOLTAGE CIRCUIT BREAKER WITH TRIP RATING SHOWN, 3-POLE, UNO
- 1 — MAGNETICALLY HELD CONTACTOR, 3-POLE, WITH NEMA SIZE SHOWN
- SAFETY DISCONNECT SWITCH, 3-POLE, HORSEPOWER RATED
- VACUUM INTERRUPTER SWITCH
- CURRENT TRANSFORMER
- POTENTIAL TRANSFORMERS (OPEN-DELTA CONNECTION SHOWN, OTHER CONNECTIONS AS INDICATED)
- SURGE ARRESTER
- OL — THERMAL OR ELECTRONIC OVERLOADS, AS SPECIFIED
- FUSE
- FUSED SWITCH
- FUSED CUTOUT
- DISCONNECT SWITCH
- LA — LIGHTNING ARRESTER

ONE-LINE (CONTINUED)

- BUS - RATINGS AS INDICATED
- EQUIPMENT ENCLOSURE
- ETHERNET
- SYSTEM LINK (SOFTWARE OR DATA LINK)
- DUAL SENSING FUSE WITH IN-LINE CURRENT LIMITING BACKUP FUSE
- NEUTRAL CONNECTION POINT
- POWER, CT, OR PT CONNECTION
- CONTROL CONNECTION
- 15 — MOTOR WITH HORSEPOWER RATING SHOWN
- MO — MOTOR OPERATOR
- K — KEY INTERLOCK
- M — METER (KWH)
- E — ELECTRICAL INTERLOCK
- ST — SHUNT TRIP
- POWER RECEPTACLE
- RF — RF/EMI FILTER ASSEMBLY
- HF — HEMP FILTER ASSEMBLY
- BATTERY
- BUS DUCT
- XXX / XXX — EQUIPMENT; SEE ABBREVIATION LIST FOR IDENTIFICATION
- 1 — SWITCHGEAR BREAKER NUMBER

SCHEMATICS

- TEMPERATURE SWITCH-OPENS ON INCREASING TEMPERATURE
- TEMPERATURE SWITCH-CLOSES ON INCREASING TEMPERATURE
- MOMENTARY PUSHBUTTON, NORMALLY OPEN
- MOMENTARY PUSHBUTTON, NORMALLY CLOSED
- G — INDICATING LIGHT WITH COLOR (G=GREEN, R=RED, W=WHITE)
- NORMALLY OPEN CONTACT
- NORMALLY CLOSED CONTACT
- LOCATION SYMBOL (SEE TERMINAL BLOCKS & LOCATION SYMBOLS)
- COIL OR RELAY 42-RUNNING CIRCUIT BREAKER
- NORMALLY OPEN CONTACT WITH TIME DELAY CLOSING AFTER COIL IS ENERGIZED
- DISCONNECTING DEVICE
- CIRCUIT BREAKER
- GROUND
- TRANSFORMER
- OC — THERMAL OVERLOADS
- INTERFACE (PCMS OR SCMS)
- INPUT (PCMS OR SCMS)
- OUTPUT (PCMS OR SCMS)
- I — INTERLOCK
- LIMIT SWITCH NORMALLY OPEN
- LIMIT SWITCH NORMALLY CLOSED
- CAPACITOR
- SELECTOR SWITCH (OFF / HAND | AUTO / X00 / 0)
  - HAND - OPERATION ENABLED
  - OFF - OPERATION NOT ENABLED
  - AUTO - AUTOMATIC OPERATION ENABLED
  - X - DENOTES SELECTOR SWITCH POSITION TO CLOSE RESPECTIVE SWITCH CONTACT
- REACTOR
- EXTERNAL WIRING
- PRESSURE SWITCH
- DIODE
- COMBINATION MOTOR STARTER NEMA SIZE AS INDICATED

SCHEMATICS (CONTINUED)

- A B C — MEDIUM VOLTAGE 3 PHASE DISCONNECT LOAD INTERRUPTER WITH CTS AND PTS

GENERAL NOTES

1. ALL ELECTRICAL DISTRIBUTION EQUIPMENT SHALL HAVE A RMS SYMMETRICAL SHORT CIRCUIT RATING EQUAL TO OR GREATER THAN THE RATINGS INDICATED ON THE DRAWINGS. THE MINIMUM RMS SYMMETRICAL SHORT CIRCUIT RATING SHALL BE 10,000 AMPS FOR EQUIPMENT WITHOUT SHORT CIRCUIT RATINGS INDICATED ON DRAWINGS. IN ADDITION, ALL EQUIPMENT SHALL BE RATED GREATER THAN THE SHORT CIRCUIT STUDY CALCULATED DUTY PROVIDED BY THE CONTRACTOR IN ACCORDANCE WITH SPECIFICATION SECTION 26 28 01.00 10 COORDINATED POWER SYSTEM PROTECTION STUDY.
2. ALL ELECTRICAL WORK AND MATERIAL IS NEW, AND PROVIDED BY THE CONTRACTOR UNLESS INDICATED OTHERWISE.
3. ALL NON-CURRENT CARRYING METAL PARTS OF EQUIPMENT, ETC., SHALL BE GROUNDED BY MEANS OF GREEN INSULATED GROUND WIRE IN RACEWAY WITH SUPPLY CONDUIT SHALL BE ELECTRICALLY CONTINUOUS AND GROUNDED IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE, ARTICLE 250.
4. THE ELECTRICAL INSTALLATION SHALL COMPLY WITH ALL THE 2020 NATIONAL ELECTRICAL CODE (NEC) AND ALL OTHER GOVERNMENT CODES AND CRITERIA.
5. ALL ELECTRICAL EQUIPMENT SHALL BE UL LABELED.
6. COORDINATE ALL ELECTRICAL WORK WITH OTHER TRADES.
7. ALL ELECTRICAL EQUIPMENT SHALL BE SEISMICALLY QUALIFIED AND SUPPORTED PER THE SEISMIC REQUIREMENTS IN THE SPECIFICATIONS.
8. THE CONTRACTOR SHALL COORDINATE POWER CIRCUIT, OVERCURRENT PROTECTION, AND DISCONNECT SIZES WITH THE ACTUAL EQUIPMENT TO BE PROCURED.

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. MANNING
DRAWN BY: J. WITHROW
CHECKED BY: M. MAES
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE.
OVERLAND PARK, KS 66211

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ELECTRICAL LEGEND AND NOTES

SHEET ID
E-002

READY-TO-ADVERTISE (RTA) SUBMITTAL

POWER

- CONDUIT OF VARIOUS TYPES (CABLE TYPE THHN/THWN UNLESS NOTED OTHERWISE):
  - EXPOSED (HIDDEN FROM VIEW IN ARCHITECTURALLY FINISHED SPACES)
  - CONCEALED CONDUIT (ROUTED IN OR BELOW CONCRETE/SLAB)
- CONDUIT TERMINATION IN TRAY OR TRENCH WITH BUSHING
- CONDUIT TURNING DOWN (NOT TO SCALE)
- CONDUIT TURNING UP (NOT TO SCALE)
- CONDUIT PASSING THROUGH ELEVATION (NTS)
- CONDUIT FITTING
- CONDUIT CAP/TRANSITION FROM CONDUIT TO DIRECT BURIED CABLE
- JUNCTION BOX, SIZED PER NEC (J)TB
  - TB= PROVIDED WITH TERMINAL BLOCK
- (M) MOTOR
- ELECTRICAL EQUIPMENT AS NOTED ON PLANS (SWITCHGEAR, PANELBOARD, TRANSFORMER, ETC.)

GROUNDING

- CONCEALED GROUND CONDUCTOR #4/0 AWG BARE COPPER, UNLESS OTHERWISE NOTED
- CONCEALED GROUND STINGER TO EQUIPMENT OR STEEL #4/0 AWG BARE COPPER, UNLESS OTHERWISE NOTED
- GROUND CONDUCTOR DOWN
- GROUND CONDUCTOR UP
- FP FLUSH GROUND PLATE
- EXOTHERMIC WELD TO EQUIPMENT OR BUILDING STEEL
- EXOTHERMIC WELD, UNLESS NOTED OTHERWISE
- 3/4" x 10' GROUND ROD UNLESS OTHERWISE NOTED ON RESPECTIVE SHEET. TOP OF ROD AT LEAST 18" BELOW GRADE. DEVIATION NOTED ON RESPECTIVE SHEET.
- GROUND TEST WELL WITH GROUND ROD
- GROUND WELL
- SITE GROUND WELL
- BOLTED GROUND CONNECTION TO EQUIPMENT
- BARE CU GROUND CONDUCTOR COILED ABOVE GRADE FOR FUTURE CONNECTION SIZE AS INDICATED
- XX GROUND BAR
  - GB: GROUND BAR
  - MGB: MAIN POWER GROUND BAR
  - PBB: COMM PRIMARY BONDING BUSBAR
  - SBB: COMM SECONDARY BONDING BUSBAR

SITE

- ELECTRICAL MANHOLE
- H ELECTRICAL HANDHOLE
- SPECIAL MANHOLE VAULT WITH PROVISIONS FOR 4 WAY SWITCHGEAR OR FUTURE SWITCHGEAR
- SPECIAL MANHOLE VAULT WITH PROVISIONS FOR 6 WAY SWITCHGEAR OR FUTURE SWITCHGEAR
- C COMMUNICATIONS MANHOLE
- BORE PIT
- S SECURITY MANHOLE
- V CABLE VAULT
- Z SHIELDED MANHOLE
- TRANSFORMER
- SITE GROUND WELL
- — — EDB — — ELECTRICAL DUCTBANK
- — — —E— — — DIRECT BURIED CONDUIT FOR TRENCHING

MISCELLANEOUS

- CROSS HATCHED EQUIPMENT TO BE DEMOLISHED
- EXTENT OF EXISTING BUILDING
- E-005 HEMP/RF/EMI SHIELD PENETRATION NUMBER
- INTERFACE POINT
- FUTURE COMPONENTS
- NEW WORK
- EXISTING WORK (SCREENED)
- HEMP/RF/EMI SHIELDING
- WBC WAVEGUIDE BELOW CUTOFF HEMP SHIELD PENETRATION

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. MANNING	ISSUE DATE: 07/03/2024
DRAWN BY: J. WITHROW	SOLICITATION NO.: W9128F24R0066
CHECKED BY: M. PARSONS	CONTRACT NO.: TBD
SUBMITTED BY: C. PRZYGODA	
SIZE: ANSI D	

US ARMY CORPS OF ENGINEERS
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BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ELECTRICAL LEGEND AND NOTES

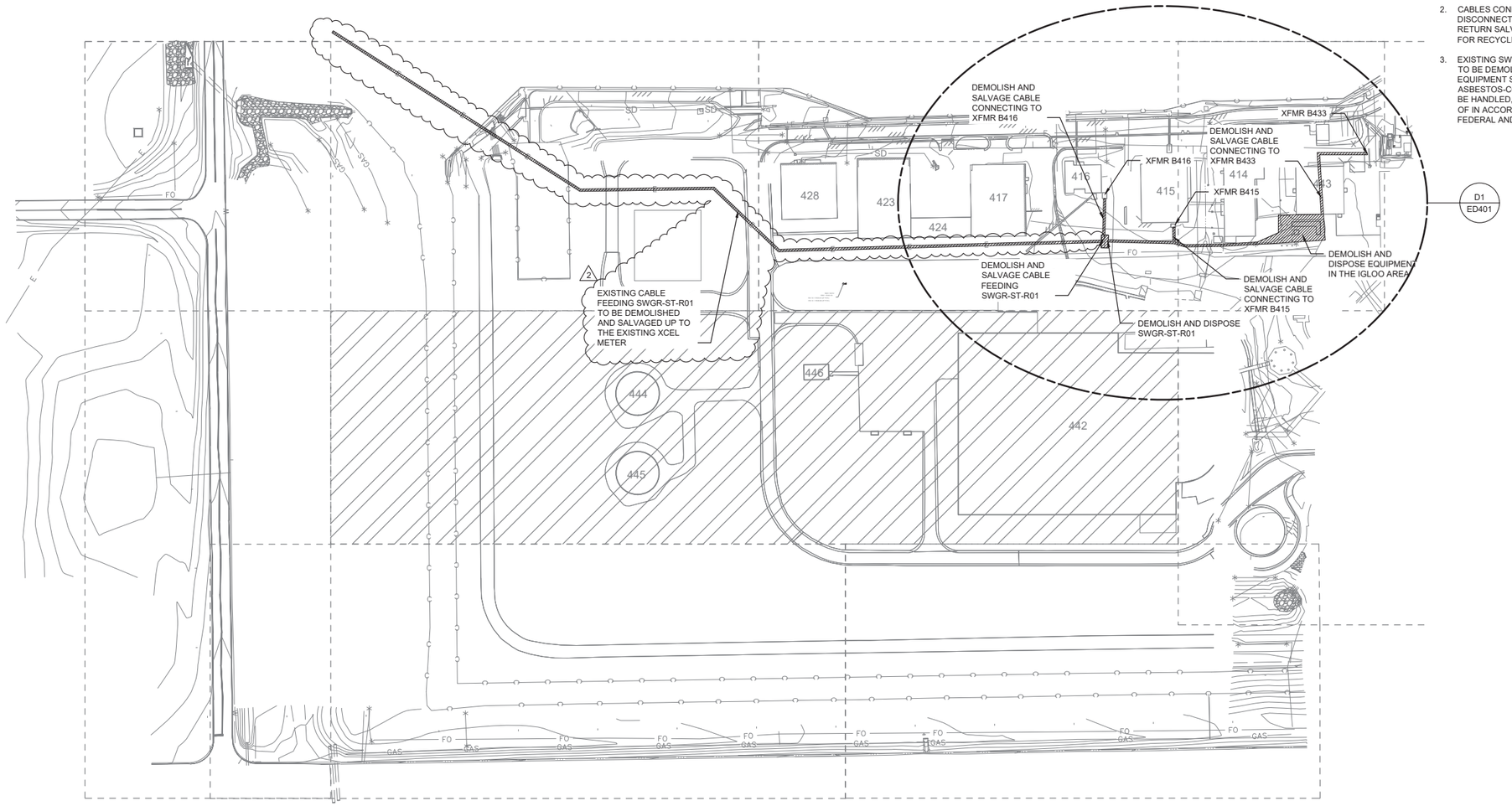
SHEET ID

E-003

READY-TO-ADVERTISE (RTA) SUBMITTAL

GENERAL SHEET NOTES:

1. FOR ELECRICAL GENERAL NOTES, LEGEND AND ABBREVIATIONS, SEE DRAWING E-001 THROUGH E-003.
2. CABLES CONNECTING UNDERGROUND TO BE DISCONNECTED AND SALVAGED IF POSSIBLE. RETURN SALVAGED EQUIPMENT TO BUCKLEY FOR RECYCLING OR REUSE.
3. EXISTING SWGR-ST-R01 AND IGLOO EQUIPMENT TO BE DEMOLISHED AND DISPOSED. THIS EQUIPMENT SHALL BE ASSUMED TO BE ASBESTOS-CONTAINING MATERIAL AND SHALL BE HANDLED, TRANSPORTED, AND DISPOSED OF IN ACCORDANCE WITH APPLICABLE FEDERAL AND STATE REGULATIONS.



D1 ELECTRICAL DEMO OVERALL SITE PLAN

SCALE: 1" = 80'

LEGEND

AC UNIT	GAS METER	STEEL POST		FENCE		FOUND ELECTRIC	
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE		HIGH SECURITY FENCE		FOUND COMMUNICATIONS	
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE		FLOW LINE		FOUND GAS LINE	
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK		GAS LOCATE		FOUND SANITARY SEWER	
LIGHT POLE	SANITARY MANHOLE	FENCE GATE		GUARD RAIL		FOUND STORM SEWER	
ELECTRIC CABINET	SANITARY CLEANOUT	CC CURB CUT		EDGE OF LANDSCAPING		FOUND WATER LINE	
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN		EDGE OF GRAVEL		FOUND UNK. UTILITY	
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP		PIPE			
ELECTRIC BOX	WATER VALVE		EDGE OF ASPHALT	WATER LOCATE		INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY	
FIBER OPTIC MANHOLE	FIRE HYDRANT		DRAINAGE LINE	MAJOR CONTOUR			
FIBER OPTIC VAULT	ROOF DRAIN		ELECTRIC LOCATE	MINOR CONTOUR			
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE		FIBER OPTIC LOCATE				

N

0 80' 160'

SCALE: 1" = 80'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
2	AMENDMENT 0002	08/09/24

DESIGNED BY: K. MANNING
DRAWN BY: M. REEVES
CHECKED BY: M. PARKES
ISSUE DATE: 08/09/2024
SOLICITATION NO.: W9128P24R0066
CONTRACT NO.: TBD
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8655 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-3600

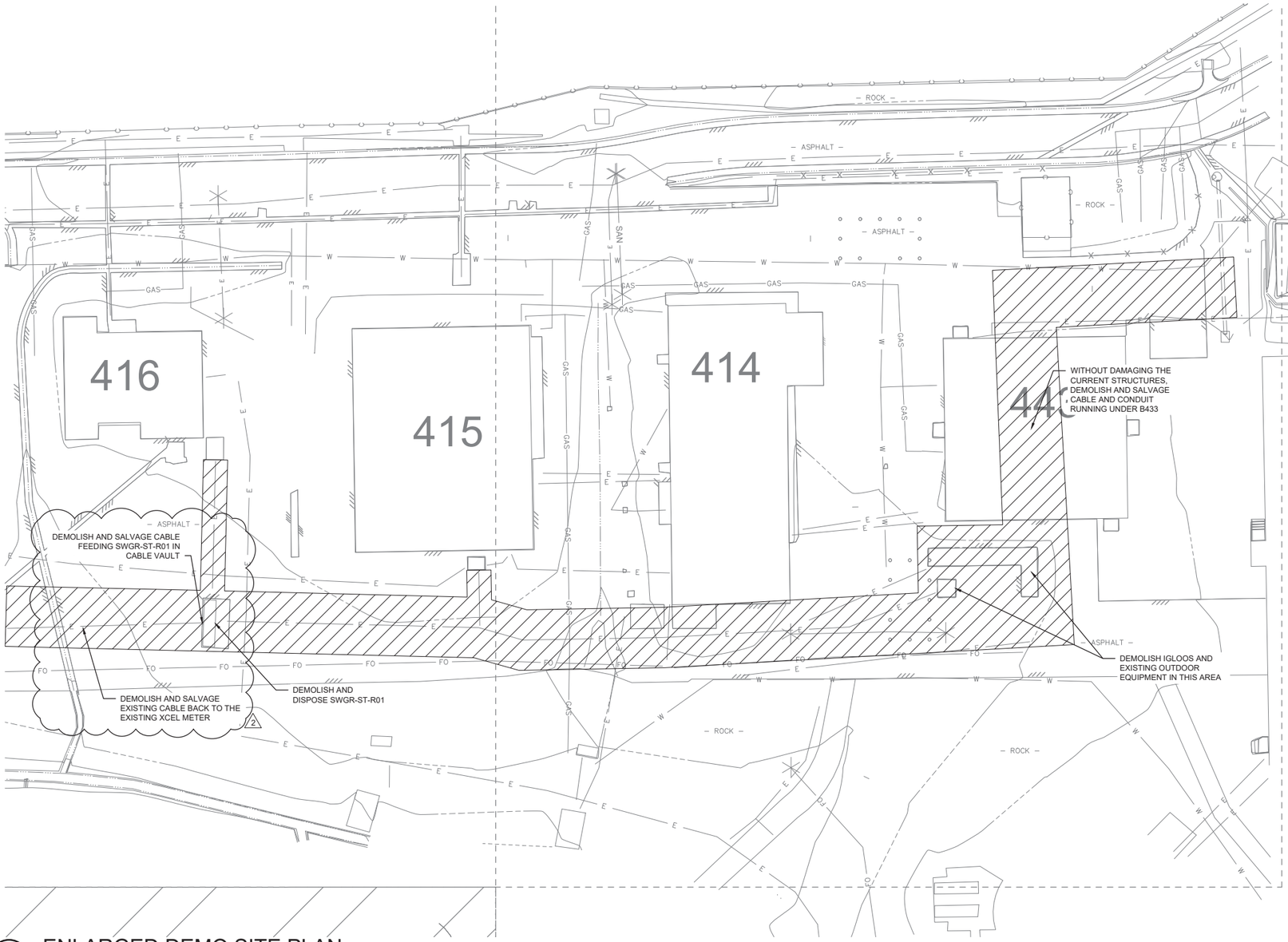
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ELECTRICAL DEMO OVERALL SITE PLAN

SHEET ID

ED101

READY-TO-ADVERTISE (RTA) SUBMITTAL



D1 ENLARGED DEMO SITE PLAN

SCALE: 1" = 20'

GENERAL SHEET NOTES:

1. FOR ELECTRICAL GENERAL NOTES, LEGEND AND ABBREVIATIONS, SEE DRAWING E-001 THROUGH E-003.
2. CABLES CONNECTING UNDERGROUND TO BE DISCONNECTED AND SALVAGED IF POSSIBLE. RETURN SALVAGED EQUIPMENT TO BUCKLEY FOR RECYCLING OR REUSE.
3. EXISTING SWGR-ST-R01 AND IGLOO EQUIPMENT TO BE DEMOLISHED AND DISPOSED. THIS EQUIPMENT SHALL BE ASSUMED TO BE ASBESTOS-CONTAINING MATERIAL AND SHALL BE HANDLED, TRANSPORTED, AND DISPOSED OF IN ACCORDANCE WITH APPLICABLE FEDERAL AND STATE REGULATIONS.
4. CONTRACTOR SHALL SUBMIT A WORK PLAN FOR APPROVAL PRIOR TO PERFORMING DEMOLITION WORK IN ACCORDANCE WITH THE SPECIFICATION. PLAN MUST BE APPROVED PRIOR TO COMMENCING WORK.
5. CONTRACTOR SHALL INSTALL NEW WORK AS SHOWN ON ES101 AND ES401 BEFORE DEMOLISHING EXISTING SWGR-ST-R01 AND CABLING AND CONDUIT TO BUILDING B415, B422, AND B416. COORDINATE WITH COR REGARDING THE DE-ENERGIZATION OF THE PRIMARY POWER SOURCE AND CIRCUITS FEEDING BUILDINGS B415, B433, AND B416.
6. THE PRIMARY CABLE ALIGNMENT (SEE CU PROFILES FOR COMPLETE EXTENTS) SHALL BE INSTALLED FIRST, PRIOR TO PROCEEDING WITH OTHER WORK. THE LINE CANNOT AND DOES NOT NEED TO BE ENERGIZED PRIOR TO PROCEEDING WITH OTHER ASPECTS OF THE PROJECT, BUT MUST BE INSTALLED AND READY TO CONNECT. 1

LEGEND

AC UNIT	GAS METER	STEEL POST		FENCE		FOUND ELECTRIC
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE		HIGH SECURITY FENCE		FOUND COMMUNICATIONS
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE		FLOW LINE		FOUND GAS LINE
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK		GAS LOCATE		FOUND SANITARY SEWER
LIGHT POLE	SANITARY MANHOLE	FENCE GATE		GUARD RAIL		FOUND STORM SEWER
ELECTRIC CABINET	SANITARY CLEANOUT	CURB CUT		EDGE OF LANDSCAPING		FOUND WATER LINE
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN		EDGE OF GRAVEL		FOUND UNK. UTILITY
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP		PIPE		
ELECTRIC BOX	WATER VALVE		EDGE OF ASPHALT	WATER LOCATE		
FIBER OPTIC MANHOLE	FIRE HYDRANT		DRAINAGE LINE	MAJOR CONTOUR		
FIBER OPTIC VAULT	ROOF DRAIN		ELECTRIC LOCATE	MINOR CONTOUR		
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE		FIBER OPTIC LOCATE			

INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY

N

0 20' 40'

SCALE: 1" = 20'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
2	AMENDMENT 0002	08/09/24
1	AMENDMENT 0001	07/30/24

ISSUE DATE: 08/09/2024
SOLICITATION NO.: W9128F-24R0066
CONTRACT NO.: TBD

DESIGNED BY: K. MANNING
DRAWN BY: M. REEVES
CHECKED BY: M. PEDERSEN
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
8685 PENROSE LANE, SUITE 300
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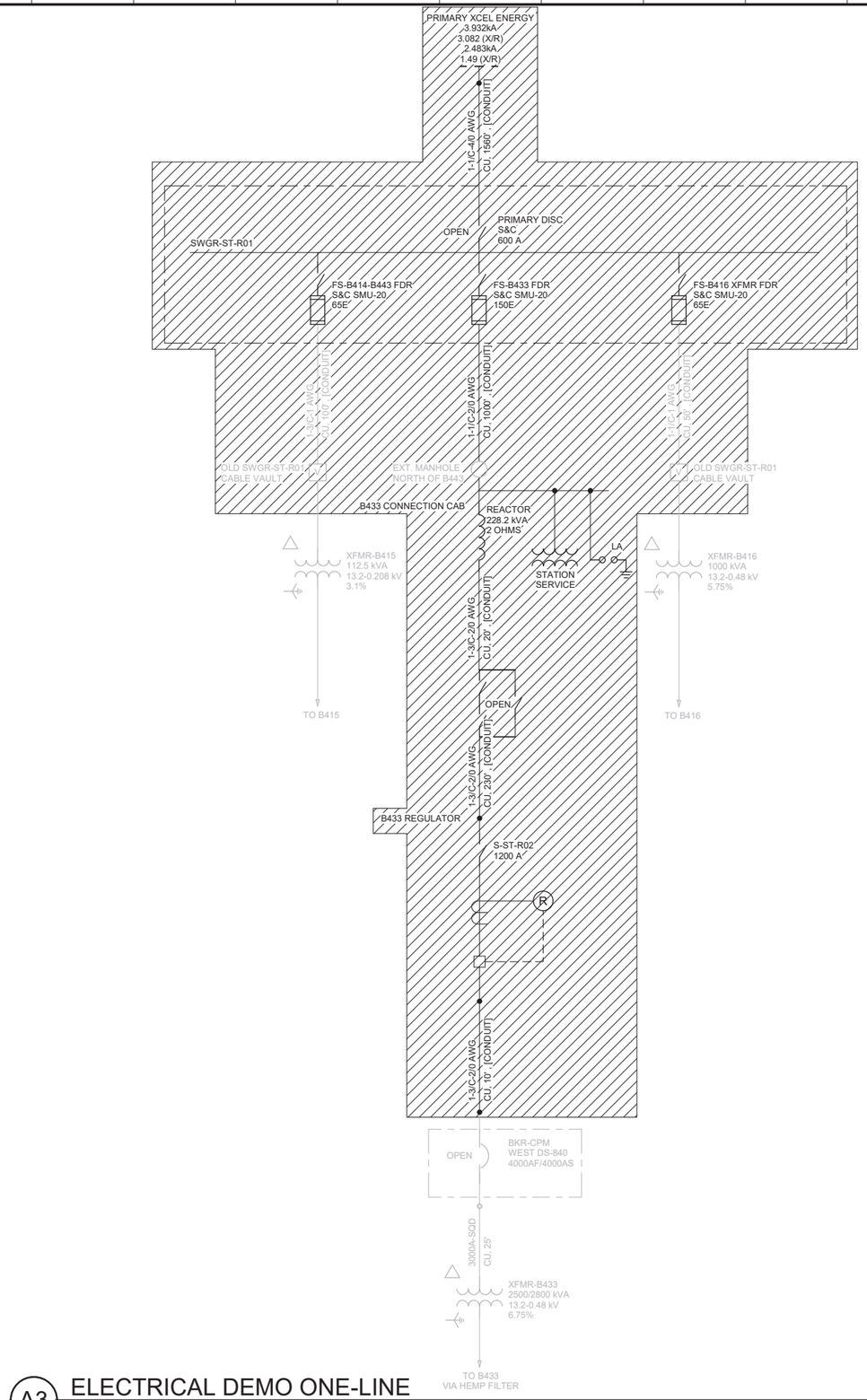
913-742-0900

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ENLARGED DEMO SITE PLAN

SHEET ID
ED401

READY-TO-ADVERTISE (RTA) SUBMITTAL



A3 ELECTRICAL DEMO ONE-LINE
NTS

GENERAL NOTES:

1. FOR ELECTRICAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS, SEE SHEETS E-001 THROUGH E-003.
2. FEEDERS, TRANSFORMERS & CIRCUIT BREAKERS TO BUILDINGS B415, B416 & B433 TO REMAIN AS APPLICABLE. FIELD TO CONFIRM.
3. REMOVE AND DISPOSE SWGR-ST-R01, IGLOOS, REACTORS AND OTHER ASSOCIATED OUTDOOR SWITCHGEAR EQUIPMENT AFTER NEW EQUIPMENT IS INSTALLED BUT BEFORE IT IS ENERGIZED. FIELD TO CONFIRM.
4. EXISTING SWITCHGEAR AND IGLOO EQUIPMENT SHALL BE ASSUMED TO BE ASBESTOS-CONTAINING MATERIAL AND SHALL BE HANDLED, TRANSPORTED, AND DISPOSED OF IN ACCORDANCE WITH APPLICABLE FEDERAL AND STATE REGULATIONS.
5. REMOVE AND SALVAGE ANY CABLE OR EQUIPMENT THAT IS TO BE DEMOLISHED. SEAL VAULT WITH A REMOVABLE COVER TO PREVENT DEBRIS FROM COLLECTING IN THE VAULT.

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. MANNING	ISSUE DATE: 07/03/2024
DRAWN BY: J. WITHROW	SOLICITATION NO.: W9128F24R0066
CHECKED BY: M. PARKER	CONTRACT NO.: TBD
SUBMITTED BY: C. PRZYGODA	
SIZE: ANSI D	

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
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BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE,
OVERLAND PARK, KS 66211

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ELECTRICAL DEMO ONE-LINE

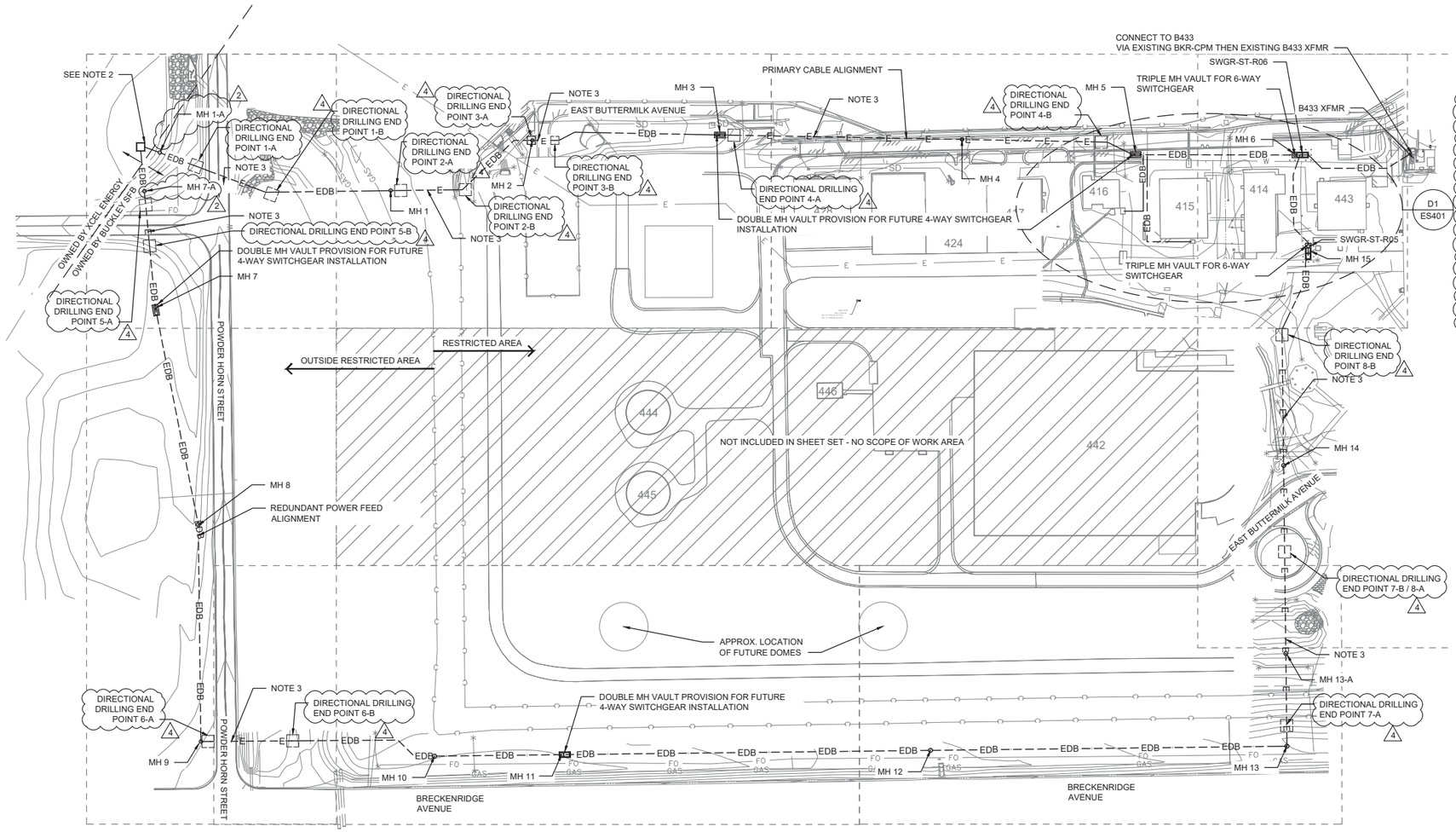
SHEET ID

ED601

READY-TO-ADVERTISE (RTA) SUBMITTAL

GENERAL SHEET NOTES:

1. FOR ELECTRICAL GENERAL NOTES, LEGEND AND ABBREVIATIONS, SEE DRAWING E-001 THROUGH E-003.
2. XCEL ENERGY TO FURNISH, PROVIDE, DESIGN, INSTALL AND MAINTAIN TWO 13.2KV POWER SOURCES, ATO, AND ATO EQUIPMENT PAD.
3. IN AREAS OF UNDERGROUND BORING USE THE MEDIUM VOLTAGE DIRECT BURIED CABLE BORING DETAIL ON E-501.
4. CONTRACTOR SHALL SUBMIT A WORK PLAN FOR APPROVAL PRIOR TO PERFORMING DEMOLITION WORK IN ACCORDANCE WITH THE SPECIFICATION. PLAN MUST BE APPROVED PRIOR TO COMMENCING WORK.
5. CONTRACTOR SHALL INSTALL NEW WORK AS SHOWN ON ES101 AND ES401 BEFORE DEMOLISHING EXISTING SWGR-ST-R01 AND CABLING AND CONDUIT TO BUILDING B415, B422, AND B416. COORDINATE WITH COR REGARDING THE DE-ENERGIZATION OF THE PRIMARY POWER SOURCE AND CIRCUITS FEEDING BUILDINGS B415, B433, AND B416.
6. THE PRIMARY CABLE ALIGNMENT (SEE CU PROFILES FOR COMPLETE EXTENTS) SHALL BE INSTALLED FIRST, PRIOR TO PROCEEDING WITH OTHER WORK. THE LINE CANNOT AND DOES NOT NEED TO BE ENERGIZED PRIOR TO PROCEEDING WITH OTHER ASPECTS OF THE PROJECT, BUT MUST BE INSTALLED AND READY TO CONNECT. (2)



D1 ELECTRICAL OVERALL SITE PLAN

SCALE: 1" = 80'

LEGEND

AC UNIT	GAS METER	STEEL POST		FENCE		FOUND ELECTRIC	
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE		HIGH SECURITY FENCE		FOUND COMMUNICATIONS	
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE		FLOW LINE		FOUND GAS LINE	
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK		GAS LOCATE		FOUND SANITARY SEWER	
LIGHT POLE	SANITARY MANHOLE	FENCE GATE		GUARD RAIL		FOUND STORM SEWER	
ELECTRIC CABINET	SANITARY CLEANOUT	CC CURB CUT		EDGE OF LANDSCAPING		FOUND WATER LINE	
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN		EDGE OF GRAVEL		FOUND UNK. UTILITY	
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP		PIPE		INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY	
ELECTRIC BOX	WATER VALVE		EDGE OF ASPHALT	WATER LOCATE			
FIBER OPTIC MANHOLE	FIRE HYDRANT		DRAINAGE LINE	MAJOR CONTOUR			
FIBER OPTIC VAULT	RD ROOF DRAIN		ELECTRIC LOCATE	MINOR CONTOUR			
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE		FIBER OPTIC LOCATE				

N

0 80' 160'

SCALE: 1" = 80'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
4	AMENDMENT 0004	09/13/24
3	AMENDMENT 0002	08/09/24
2	AMENDMENT 0001	07/30/24

DESIGNED BY: K. MANNING
DRAWN BY: M. REEVES
CHECKED BY: M. HAYES
ISSUE DATE: 08/09/2024
SOLICITATION NO.: W9128F-24R0066
CONTRACT NO.: TBD
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DIST RICO
1616 CAPITOL AVENUE
OMAHA, NE 68102

YAEGER ARCHITECTURE
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LENEXA, KS 66219
913-742-3000

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ELECTRICAL OVERALL SITE PLAN

SHEET ID
ES101

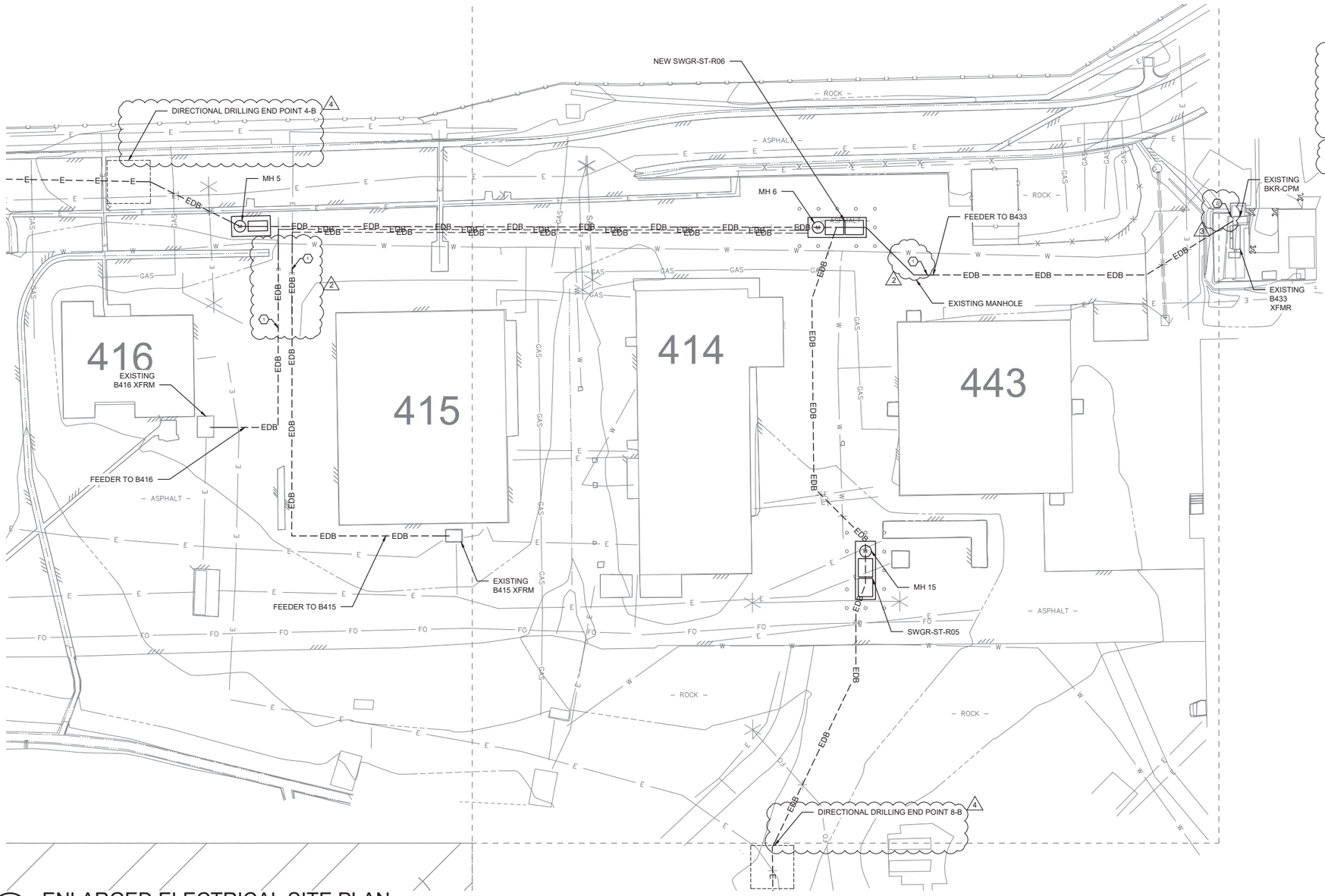
READY-TO-ADVERTISE (RTA) SUBMITTAL

GENERAL SHEET NOTES:

1. FOR ELECRICAL GENERAL NOTES, LEGEND AND ABBREVIATIONS, SEE DRAWING E-001 THROUGH E-003.
2. USE 2X2 DUCTBANK EVERYWHERE ELECTRICAL DUCTBANK IS REQUIRED UNLESS OTHERWISE NOTED.

SHEET KEYNOTES:

1. USE 2X1 ELECTRICAL DUCTBANK FROM THE SWITCHGEAR TO THE NEXT PIECE OF ELECTRICAL EQUIPMENT.
2. ROUTE DUCTBANK TO EXISTING UNDERGROUND VAULT BENEATH EXISTING BKR-CPM.



D1 ENLARGED ELECTRICAL SITE PLAN

SCALE: 1" = 20'

LEGEND

AC UNIT	GAS METER	STEEL POST		FENCE		FOUND ELECTRIC
LANDSCAPE LIGHT	GAS VALVE	DECIDUOUS TREE		HIGH SECURITY FENCE		FOUND COMMUNICATIONS
ELECTRIC MANHOLE	GAS MANHOLE	CONIFEROUS TREE		FLOW LINE		FOUND GAS LINE
ELECTRIC TRANSFORMER	VALVE BOX	LANDSCAPE ROCK		GAS LOCATE		FOUND SANITARY SEWER
LIGHT POLE	SANITARY MANHOLE	FENCE GATE		GUARD RAIL		FOUND STORM SEWER
ELECTRIC CABINET	SANITARY CLEANOUT	CURB CUT		EDGE OF LANDSCAPING		FOUND WATER LINE
ELECTRIC VAULT	WATER SHUTOFF VALVE	SIGN		EDGE OF GRAVEL		FOUND UNK. UTILITY
ELECTRIC SERVICE	WATER MANHOLE	HANDICAP RAMP		PIPE		
ELECTRIC BOX	WATER VALVE	EDGE OF ASPHALT		WATER LOCATE		INDICATES UTILITY FOUND AND MAPPED VIA GROUND PENETRATING RADAR, SEPARATE FROM TOPOGRAPHIC SURVEY
FIBER OPTIC MANHOLE	FIRE HYDRANT	DRAINAGE LINE		MAJOR CONTOUR		
FIBER OPTIC VAULT	ROOF DRAIN	ELECTRIC LOCATE		MINOR CONTOUR		
TELEPHONE MANHOLE	UNKNOWN UTILITY MANHOLE	FIBER OPTIC LOCATE				

N

0 20' 40'

SCALE: 1" = 20'

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
4	AMENDMENT 0004	09/13/24
3	AMENDMENT 0003	08/23/24
2	AMENDMENT 0002	08/09/24

ISSUE DATE: 08/09/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

DESIGNED BY: K. MANNING
DRAWN BY: M. REEVES
CHECKED BY: M. PARKES
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

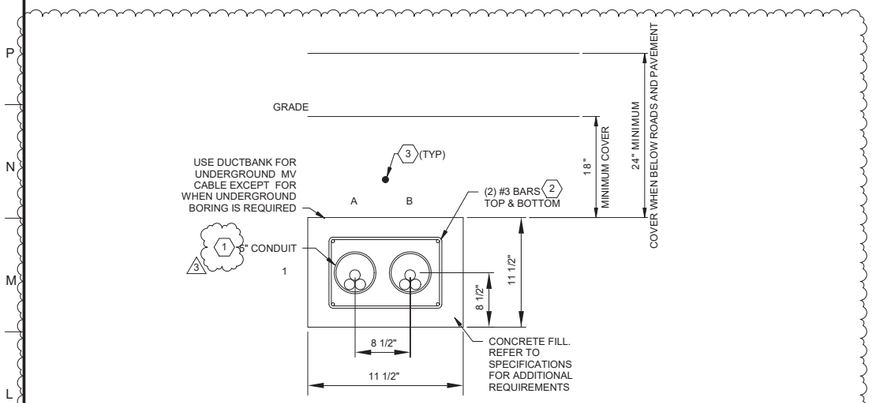
YAEGER ARCHITECTURE
8685 PENROSE LANE, SUITE 300
LENEXA, KS 66219
913-742-0900

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

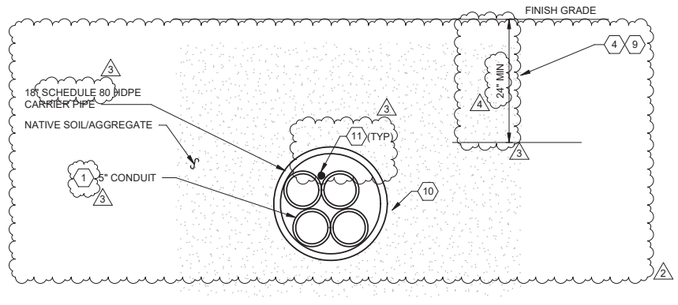
ENLARGED ELECTRICAL SITE PLAN

SHEET ID
ES401

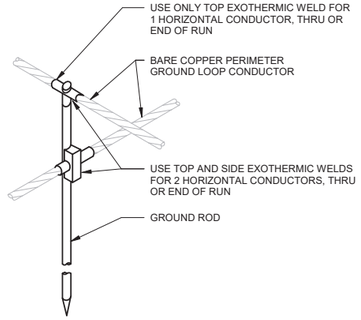
READY-TO-ADVERTISE (RTA) SUBMITTAL



L2 MEDIUM VOLTAGE 2 X 1 WAY CONDUIT DUCTBANK DETAIL
NTS



H1 MEDIUM VOLTAGE CONDUIT AND CASING DETAIL
NTS



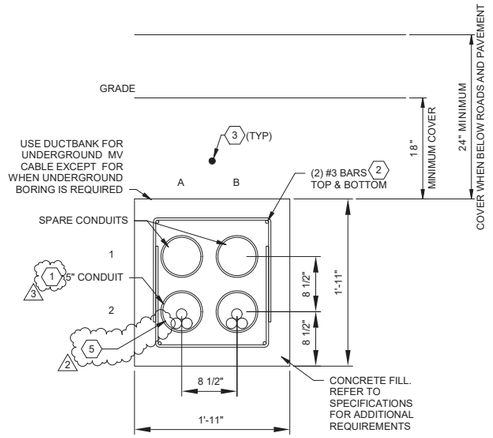
H11 GROUND LOOP TO ROD CONNECTION EXOTHERMIC PROCESS
NTS

GENERAL NOTES:

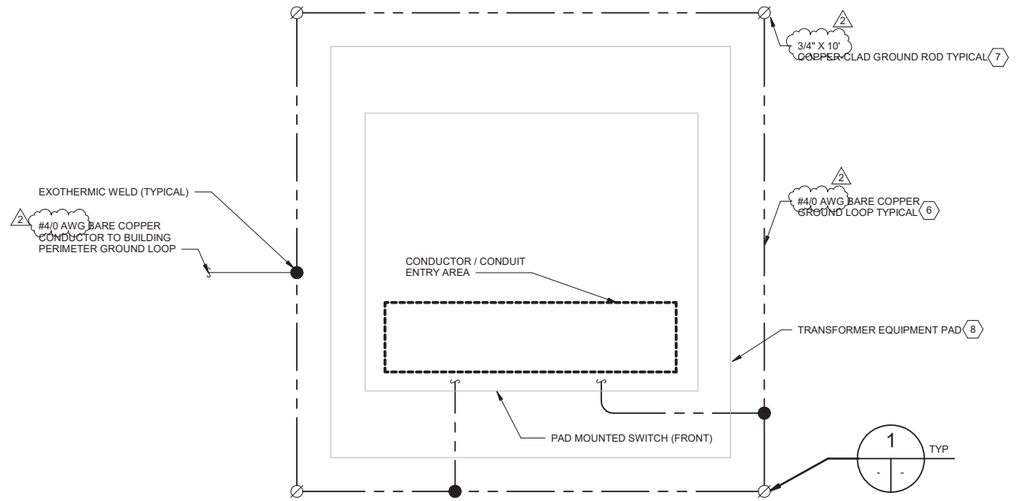
1. FOR ELECTRICAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS, SEE SHEETS E-001 THROUGH E-003.
2. REINFORCED CONCRETE ENCASED DUCTBANK SHALL BE USED AT ALL LOCATIONS, UNO.
3. PROVIDE DUCTSPACER SUPPORTS EVERY 5'-0" O.C. ALONG LENGTH OF THE DUCTBANK TO PREVENT CONDUITS FROM SAGGING AND PRESERVE INTENDED DUCTBANK CONDUIT SPACING. STAGGER SPACERS.
4. BEFORE POURING CONCRETE SECURE CONDUITS, DUCTSPACERS, ETCETERA TO PREVENT DUCTBANK CONDUIT SPACING FROM BEING ALTERED.

SHEET KEYNOTES:

1. ALL CONDUITS SHALL BE 5 INCH CONDUIT SCHEDULE 40 PVC (5.563 INCH O.D.), UNO.
2. ALL TIE BARS SHALL BE #3 STEEL REINFORCING BARS SPACED 2'-0" O.C. ALL CONCRETE COVER DIMENSIONS ARE CLEAR COVER DIMENSIONS. THREE INCH MINIMUM CONCRETE CLEAR COVER OVER REBAR SHALL BE MAINTAINED ON ALL SIDES OF THE DUCTBANK.
3. ALL CONCRETE ENCASED PVC ELECTRICAL POWER DUCTBANKS SHALL HAVE A #4/0 AWG BARE COPPER GROUND CONDUCTOR ROUTED ABOVE THE DUCTBANK. BOND THE GROUND CONDUCTOR TO THE INTERCONNECT BUILDING GROUNDING SYSTEMS.
4. PROVIDE 6-INCH WIDE DETECTABLE LOCATOR/WARNING TAPE ABOVE ALL BURIED UNDERGROUND CONDUIT WITHOUT CONCRETE ENCASEMENT. COORDINATE TAPE MARKING TO MEET BASE UTILITY STANDARDS AND DEPTH BELOW FINISHED GRADE.
5. USE DIRECT BURIED HDPE CARRIER PIPE DURING SECTIONS OF UNDERGROUND DIRECTIONAL DRILLING.
6. PERIMETER GROUND LOOP CONDUCTOR SHALL BE BURIED NO LESS THAN 30 INCHES BELOW FINISHED GRADE.
7. GROUND RODS SHALL BE DRIVEN VERTICALLY SO THAT TOP OF ROD IS MINIMUM 18 INCHES BELOW FINISHED GRADE.
8. FOR DETAILS OF SWITCH VAULT WITH PAD, SEE SHEET E-502 THROUGH E-504.
9. REFER TO SPECIFICATION 330523.13 UTILITY HORIZONTAL DIRECTIONAL DRILLING FOR ADDITIONAL INSTRUCTIONS.
10. THE THIRD AND FOURTH CONDUITS TO BE PULLED THROUGH THE CARRIER PIPE SHOULD BE BOUND TOGETHER AND PULLED AS A SINGLE UNIT TO ENSURE FIT.
11. ROUTE A #4/0 AWG BARE COPPER GROUND CONDUCTOR WITH THE ELECTRICAL CONDUITS INSIDE THE CARRIER PIPE. BOND THE GROUND CONDUCTOR TO THE DUCTBANK GROUND SYSTEM AND BUILDING GROUNDING SYSTEMS.



A2 MEDIUM VOLTAGE 2 X 2 WAY CONDUIT DUCTBANK DETAIL
NTS



A12 PAD MOUNTED SWITCH GROUNDING PLAN VIEW
NTS

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
4	AMENDMENT 0004	09/13/24
3	AMENDMENT 0003	08/23/24
2	AMENDMENT 0002	08/09/24

DESIGNED BY: K. MANNING
DRAWN BY: J. WITHROW
CHECKED BY: M. RAMIREZ
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

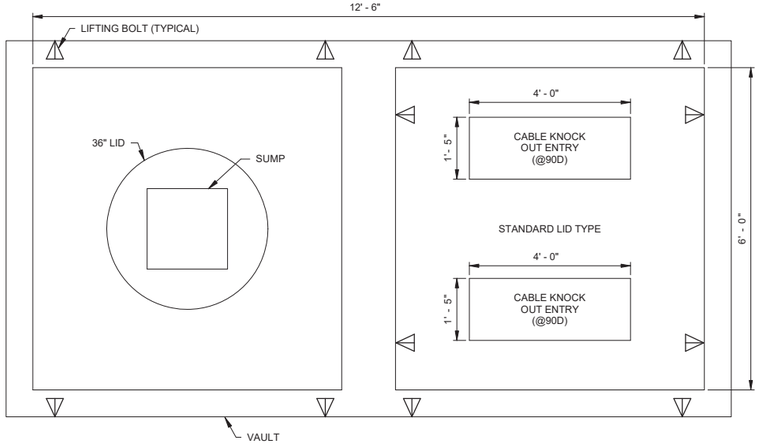
BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE.
OVERLAND PARK, KS 66211

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

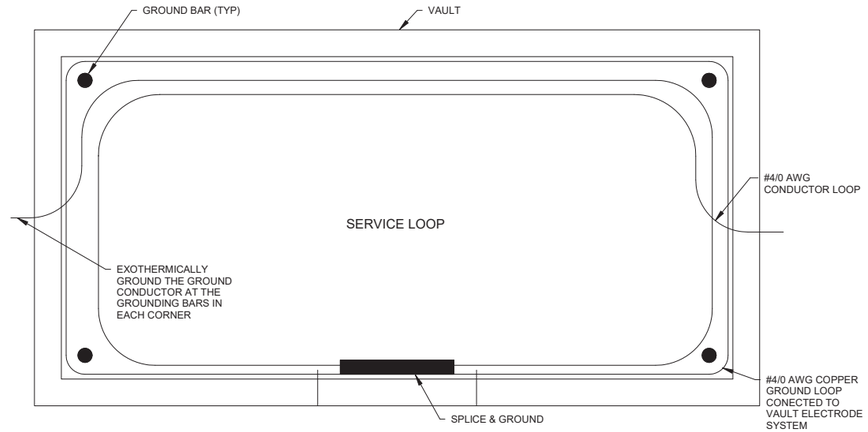
DUCTBANK AND BORING TRENCH DETAILS

SHEET ID
E-501

READY-TO-ADVERTISE (RTA) SUBMITTAL



K1 DOUBLE MANHOLE AND SWITCHGEAR VAULT LIDS DETAIL
NTS



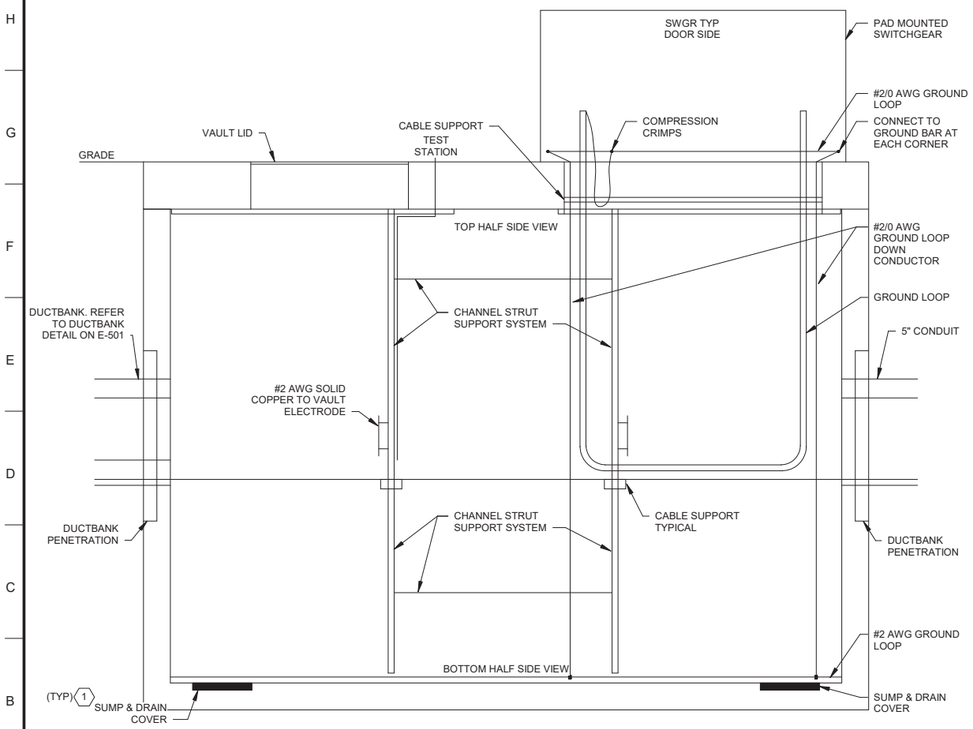
K9 DOUBLE MANHOLE AND SWITCHGEAR VAULT INSIDE TOP VIEW DETAIL
NTS

GENERAL NOTES:

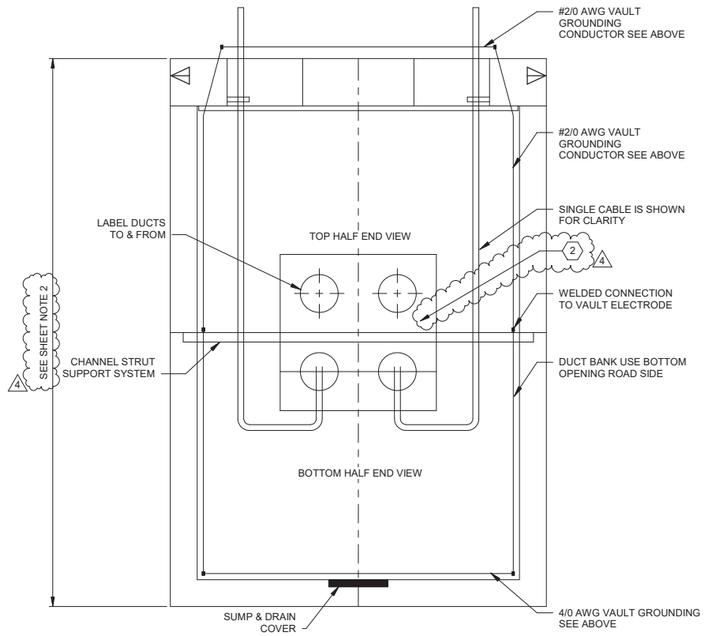
1. FOR ELECTRICAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS, SEE SHEETS E-001 THROUGH E-003.
2. TWO RINGED MANHOLE LIDS ARE REQUIRED FOR PULL POINT VAULTS, CONTRACTOR TO VERIFY VAULT LID HAS PROVISIONS FOR FUTURE PADMOUNTED SWITCHGEAR.
3. NESC RULE 350 BOND ALL ABOVE GROUND METALLIC POWER AND COMMUNICATIONS PEDESTALS THAT ARE SEPARATED BY SIX (6') FEET OR LESS; USE MINIMUM #6 BARE COPPER DIRECT BURIED CONDUCTOR A MINIMUM 18" BELOW GRADE AND CONNECT TO LID AT SIDE NUTS USING LUG.
4. PROVIDE SERVICE LOOP IN THE CABLE FOR ALL VAULTS RACK AND SUPPORT CABLES TO VAULTS SIDE WALLS AS NEEDED TO SUPPORT CABLES.
5. FIRE TAPE AND LABEL ALL CONDUCTORS WITH PHASE TAPE AND CABLE IDENTIFICATION.
6. SEAL BETWEEN VAULT AND PRE CAST CONCRETE PAD WITH FOAM SEALER TO SEAL BETWEEN CONCRETE.
7. INSTALL ADDITIONAL GROUND RODS IF NONE ARE PRESENT.
8. ADD FILL DIRT AROUND PRE CAST PAD TO BRING GRADE LEVEL TO BOTTOM OF PAD.
9. 8' CLEAR LEVEL WORKING SPACE FOR ACCESS ALL DOORS.

SHEET KEYNOTES:

1. SEE E-505 FOR SUMP DRAIN DETAILS.
2. SEE DETAIL A12 ON E-504 FOR INFORMATION ON MANHOLE DEPTH AND CONDUIT/DUCTBANK ENTRY AND EXIT ELEVATIONS. (4)



B1 DOUBLE MANHOLE AND SWITCHGEAR VAULT FRONT PROFILE DETAIL
NTS



B10 DOUBLE MANHOLE AND SWITCHGEAR VAULT SIDE PROFILE VIEW - DUCTBANK ENTRY DETAIL
NTS

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
4	AMENDMENT 0004	09/13/24

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

DESIGNED BY: Designer
DRAWN BY: Author
CHECKED BY: Checker
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

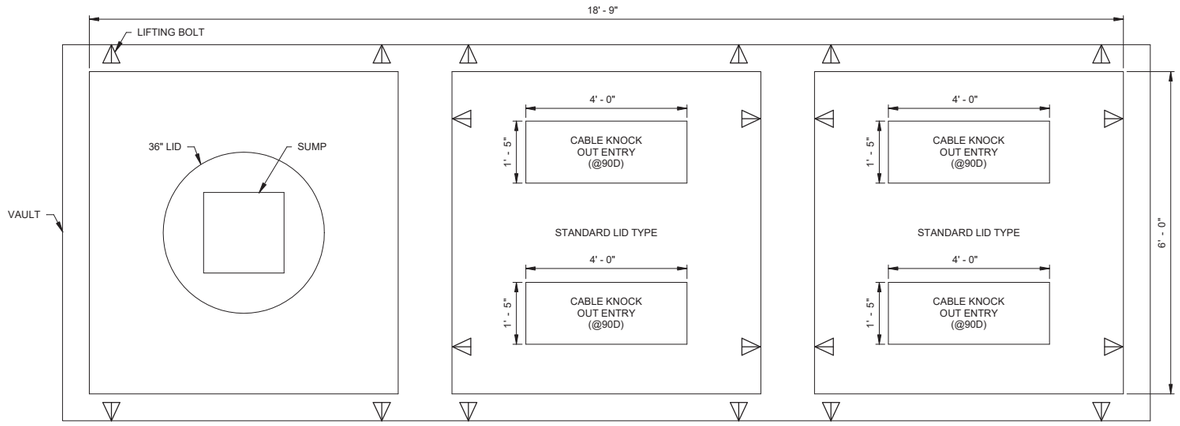
BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE.
OVERLAND PARK, KS 66211

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

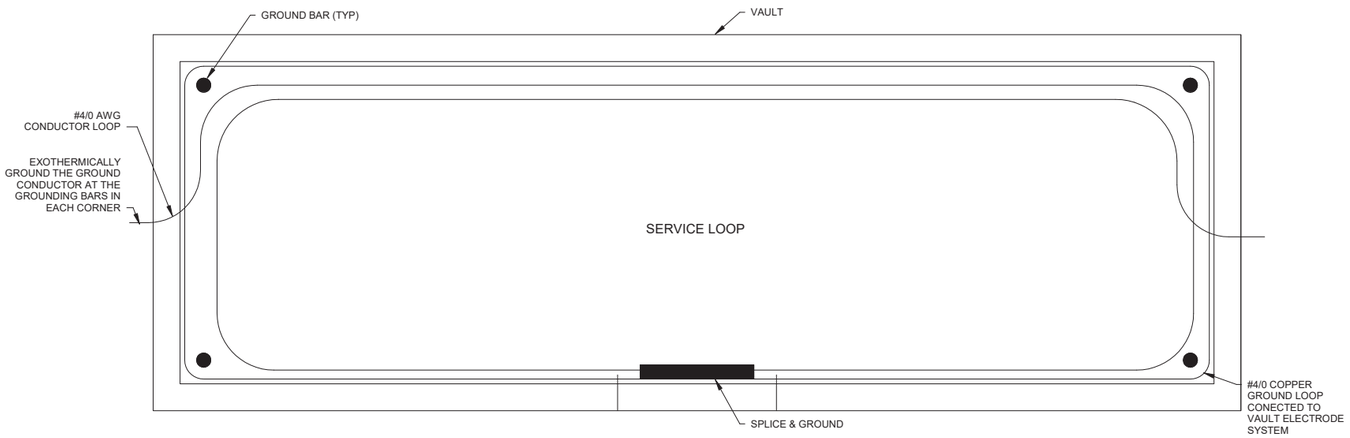
DOUBLE MANHOLE VAULT DETAILS

SHEET ID
E-502

READY-TO-ADVERTISE (RTA) SUBMITTAL



H3 TRIPLE MANHOLE AND SWITCHGEAR VAULT LIDS DETAIL
NTS



B3 TRIPLE MANHOLE AND SWITCHGEAR VAULT INSIDE TOP VIEW DETAIL
NTS

GENERAL NOTES:

1. FOR ELECTRICAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS, SEE SHEETS E-001 THROUGH E-003.
2. TWO RINGED MANHOLE LIDS ARE REQUIRED FOR PULL POINT VAULTS, CONTRACTOR TO VERIFY VAULT LID FOR PADMOUNTED SWITCHGEAR WILL ACCOMMODATE THE SWGR-ST-R05 AND SWGR-ST-R06.
3. NESC RULE 350 BOND ALL ABOVE GROUND METALLIC POWER AND COMMUNICATIONS PEDESTALS THAT ARE SEPARATED BY SIX (6') FEET OR LESS: USE MINIMUM #6 BARE COPPER DIRECT BURIED A MINIMUM 18" BELOW GRADE AND CONNECT TO LID AT SIDE NUTS USING LUG.
4. PROVIDE SERVICE LOOP IN THE CABLE FOR ALL VAULTS RACK AND SUPPORT CABLES TO VAULTS SIDE WALLS AS NEEDED TO SUPPORT CABLES.
5. FIRE TAPE AND LABEL ALL CONDUCTORS WITH PHASE TAPE AND CABLE IDENTIFICATION.
6. SEAL BETWEEN VAULT AND PRE CAST CONCRETE PAD WITH FOAM SEALER TO SEAL BETWEEN CONCRETE.
7. INSTALL ADDITIONAL GROUND RODS IF NONE ARE PRESENT.
8. ADD FILL DIRT AROUND PRE CAST PAD TO BRING GRADE LEVEL TO BOTTOM OF PAD.
9. 8' CLEAR LEVEL WORKING SPACE FOR ACCESS ALL DOORS.

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

ISSUE DATE:	07/03/2024
SOLICITATION NO.:	W9128F24R0066
CONTRACT NO.:	TBD
DESIGNED BY:	K. MANNING
DRAWN BY:	J. WITHROW
CHECKED BY:	M. KAHLER
SUBMITTED BY:	C. PRZYGODA
SIZE:	ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

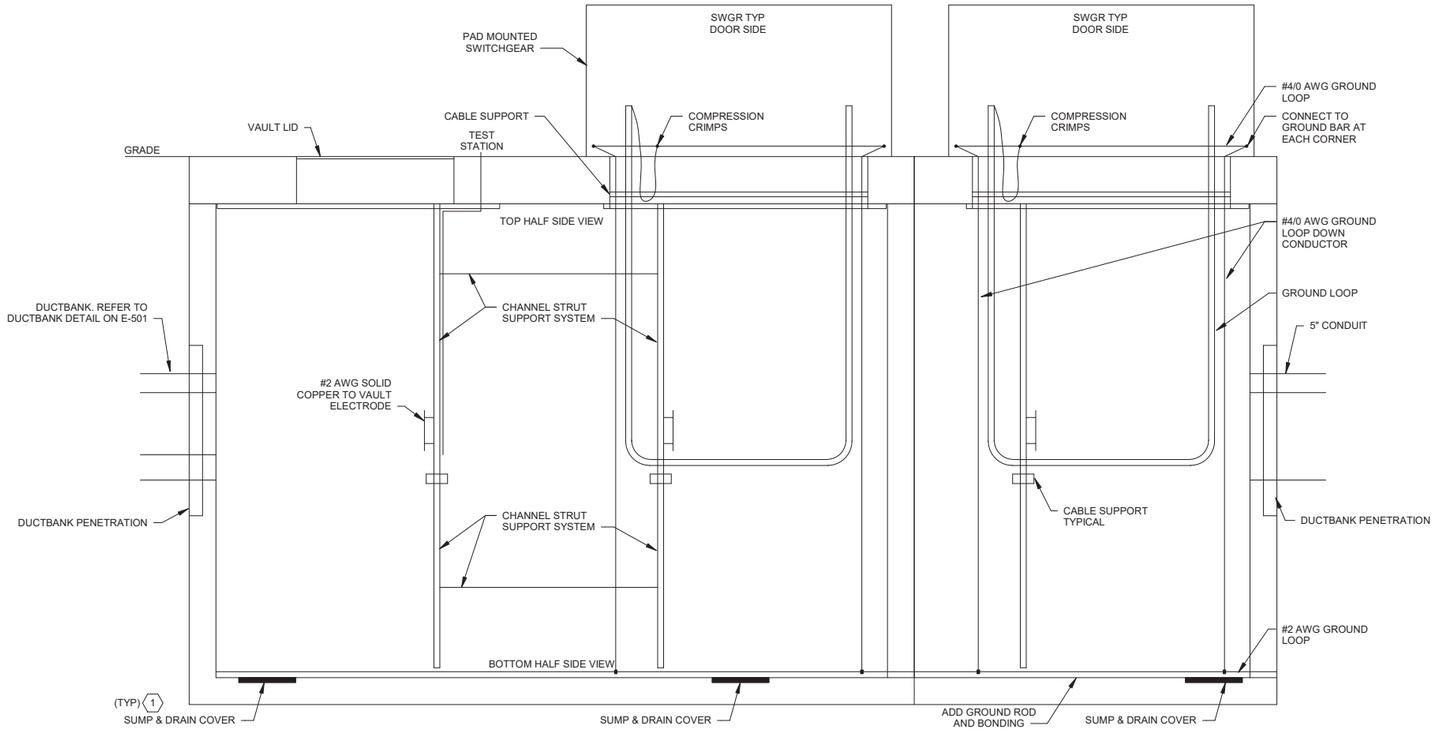
BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE.
OVERLAND PARK, KS 66211

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

TRIPLE MANHOLE VAULT DETAILS

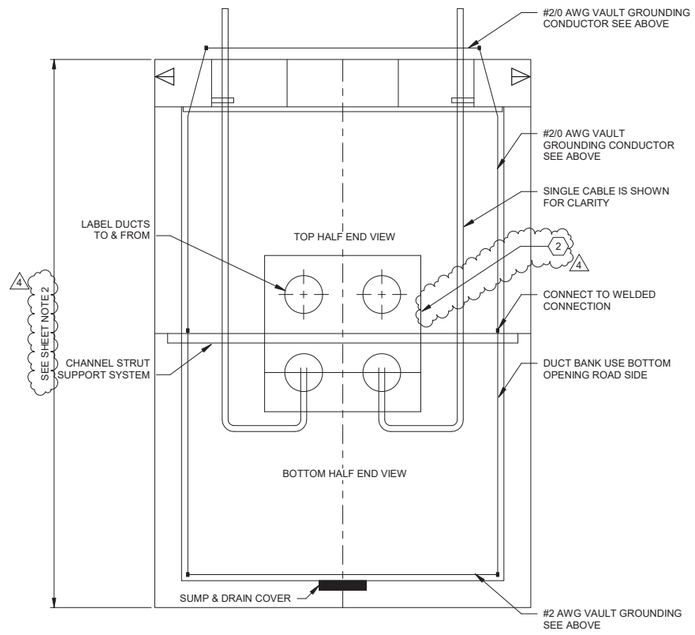
SHEET ID
E-503

READY-TO-ADVERTISE (RTA) SUBMITTAL



H1 TRIPLE MANHOLE AND SWITCHGEAR VAULT FRONT PROFILE DETAIL

3/4" = 1'-0"



A3 TRIPLE MANHOLE AND SWITCHGEAR VAULT SIDE PROFILE - DUCTBANK ENTRY DETAIL

3/4" = 1'-0"

GENERAL NOTES:

1. FOR ELECTRICAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS, SEE SHEETS E-001 THROUGH E-003.
2. TWO RINGED MANHOLE LIDS ARE REQUIRED FOR PULL POINT VAULTS, CONTRACTOR TO VERIFY VAULT LID FOR PADMOUNTED SWITCHGEAR W/LL ACCOMMODATE THE SWGR-ST-R01-6B AND SWGR-ST-R01-6A.
3. NESC RULE 350 BOND ALL ABOVE GROUND METALLIC POWER AND COMMUNICATIONS PEDESTALS THAT ARE SEPARATED BY SIX (6') FEET OR LESS: USE MINIMUM #6 BARE COPPER DIRECT BURIED A MINIMUM 18" BELOW GRADE AND CONNECT TO LID AT SIDE NUTS USING LUG.
4. PROVIDE SERVICE LOOP IN THE CABLE FOR ALL VAULTS RACK AND SUPPORT CABLES TO VAULTS SIDE WALLS AS NEEDED TO SUPPORT CABLES.
5. FIRE TAPE AND LABEL ALL CONDUCTORS WITH PHASE TAPE AND CABLE IDENTIFICATION.
6. SEAL BETWEEN VAULT AND PRE CAST CONCRETE PAD WITH FOAM SEALER TO SEAL BETWEEN CONCRETE.
7. INSTALL ADDITIONAL GROUND RODS IF NONE ARE PRESENT.
8. ADD FILL DIRT AROUND PRE CAST PAD TO BRING GRADE LEVEL TO BOTTOM OF PAD.
9. 8' CLEAR LEVEL WORKING SPACE FOR ACCESS ALL DOORS.

SHEET KEYNOTES:

1. SEE E-505 FOR SUMP DRAIN DETAILS.
4 2. SEE DETAIL A12 FOR INFORMATION ON MANHOLE DEPTH AND CONDUIT/DUCTBANK ENTRY AND EXIT ELEVATIONS.

4

Manhole #	Ductbank/Conduit Entry/Exit Elevation on MH	MH Depth
MH3	36"	7'
MH5	60"	7'
MH6	Primary Cable 42" Redundant Power 78"	8'
MH7	42" @ midpoint	7'
MH11	42" @ midpoint	7'
MH15	104"	10'

A12 SXL - Manholes

NTS

US Army Corps of Engineers ®

MARK	AMENDMENT 0004 DESCRIPTION	DATE
4		09/13/24

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

DESIGNED BY: K. MANNING
DRAWN BY: J. WITHROW
CHECKED BY: K. MANNING
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE.
OVERLAND PARK, KS 66211

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

TRIPLE MANHOLE VAULT DETAILS CONT.

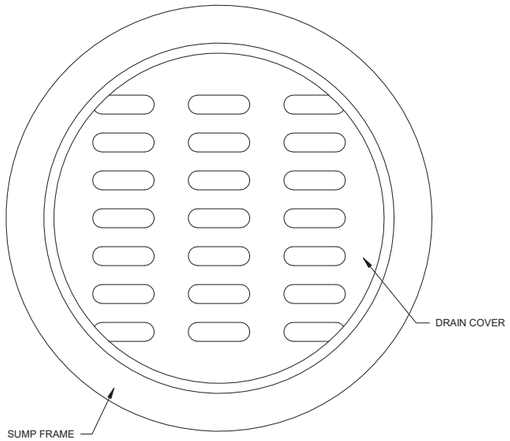
SHEET ID

E-504

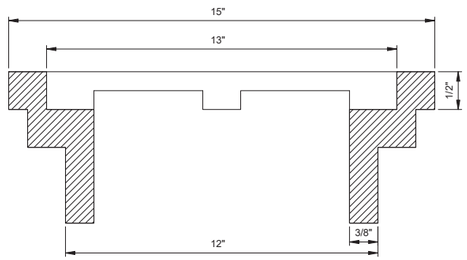
READY-TO-ADVERTISE (RTA) SUBMITTAL

GENERAL NOTES:

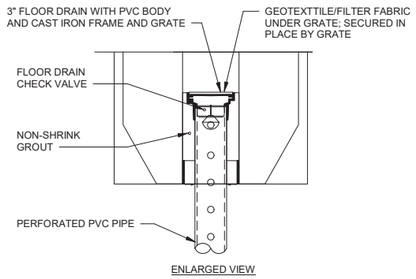
1. FOR ELECTRICAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS, SEE SHEETS E-001 THROUGH E-003.



F1 TYPICAL DRAIN COVER DETAIL
NTS



B1 TYPICAL SUMP FRAME AND COVER DETAIL
NTS



B8 TYPICAL SUMP DRAIN DETAIL
NTS

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. MANNING
DRAWN BY: J. WITHROW
CHECKED BY: M. HOLMES
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE.
OVERLAND PARK, KS 66211

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

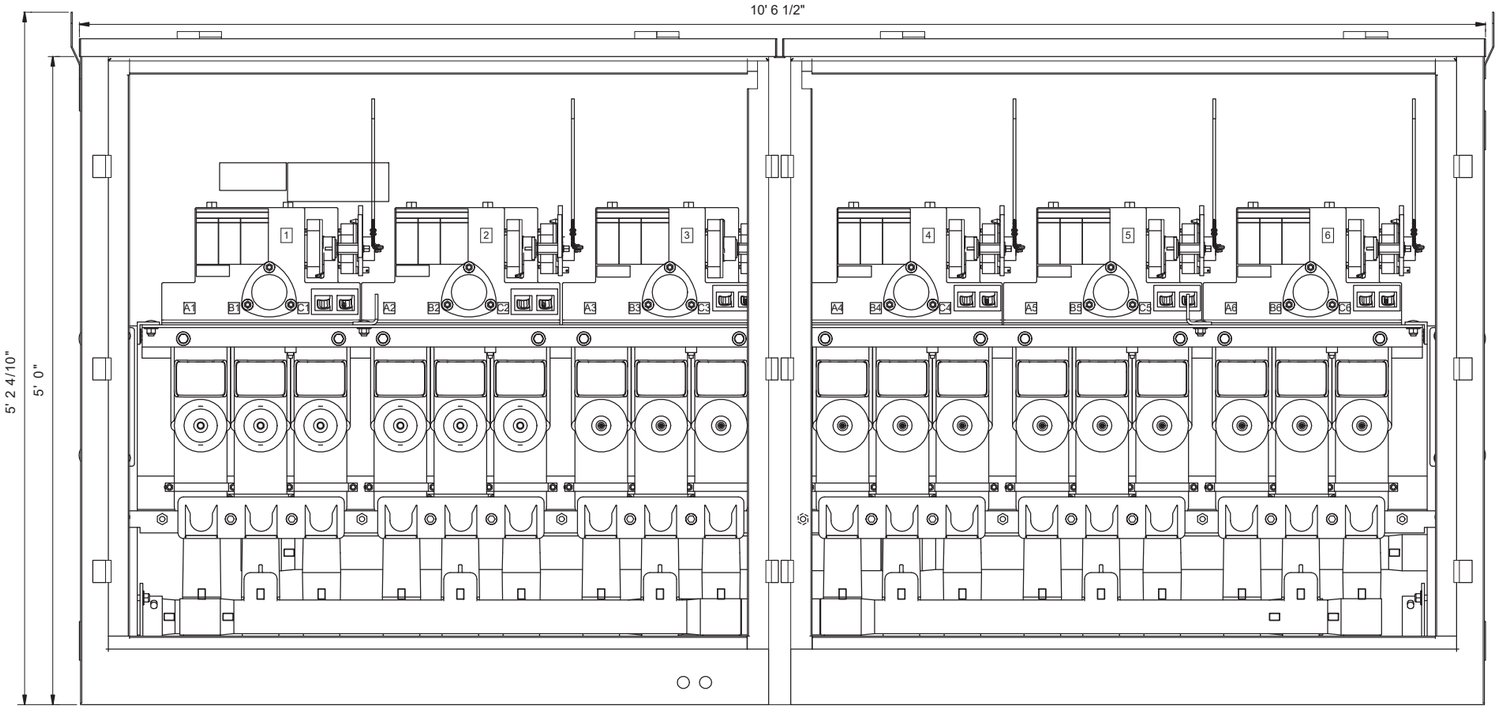
TYPICAL DRAIN DETAILS

SHEET ID
E-505

READY-TO-ADVERTISE (RTA) SUBMITTAL

GENERAL NOTES:

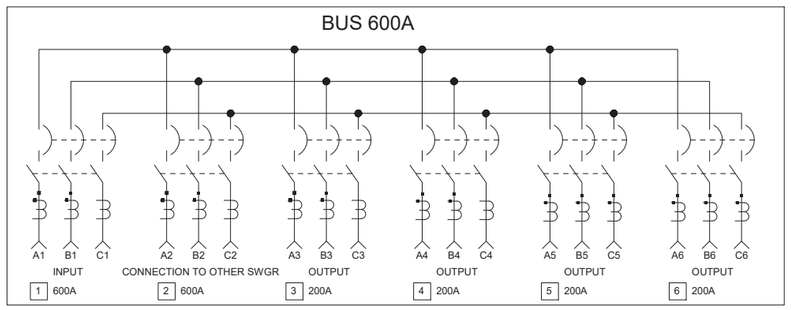
1. FOR ELECTRICAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS, SEE SHEETS E-001 THROUGH E-003.



F1 6 WAY PAD MOUNTED SWITCHGEAR ELEVATION DIAGRAM
NTS

PAD MOUNTED SWITCHGEAR ELECTRICAL INFORMATION		
	WAYS 1 & 2	WAYS 3, 4, 5 & 6
RATED VOLTAGE (MAXIMUM)	15.5 KV	15.5 KV
IMPULSE LEVEL (BIL)	95 KV	95 KV
CONTINUOUS CURRENT, RMS SYM	SEE THREE LINE DIAGRAM	
FAULT CURRENT INTERRUPTING, RMS SYM	12.5 KA	12.5 KA
AC 1 MINUTE WITHSTAND (DRY)	34 KV	34 KV
DC 15 MINUTE WITHSTAND	53 KV	53 KV
MOMENTARY CURRENT, RMS ACTION	20 KA	20 KA
MAKING CURRENT, RMS ASYM	20 KA	20 KA
SHORT-TIME WITHSTAND RATING (1 SEC. DURATION), RMS SYM	12.5 KA	12.5 KA

A1 6 WAY PAD MOUNTED SWITCHGEAR ELECTRICAL INFORMATION
NTS



THREE LINE DIAGRAM

A10 6 WAY PAD MOUNTED SWITCHGEAR THREE-LINE DIAGRAM
NTS

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: K. MANNING
DRAWN BY: J. WITHROW
CHECKED BY: M. MEEKS
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE.
OVERLAND PARK, KS 66211

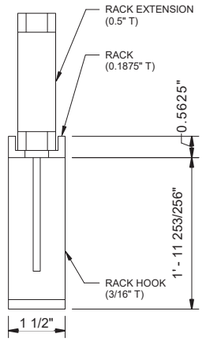
BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

6 WAY PAD MOUNTED SWITCHGEAR ONE-LINE

SHEET ID
E-506

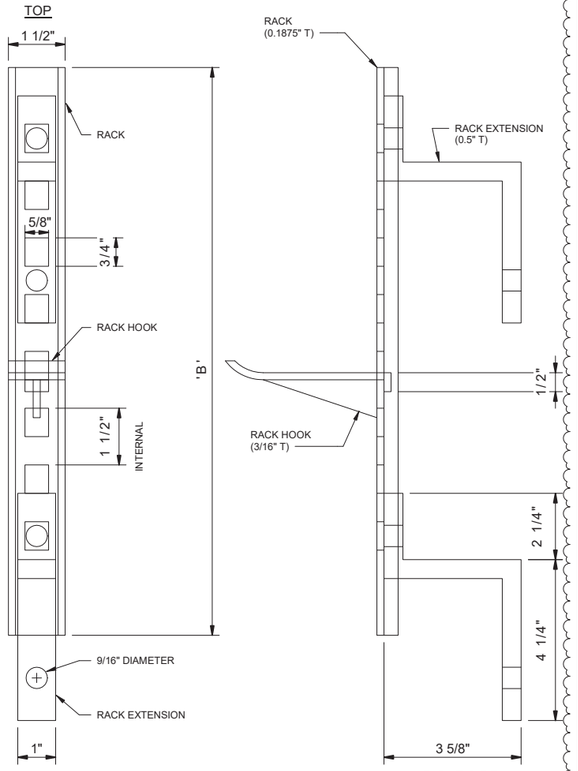
READY-TO-ADVERTISE (RTA) SUBMITTAL

CUI

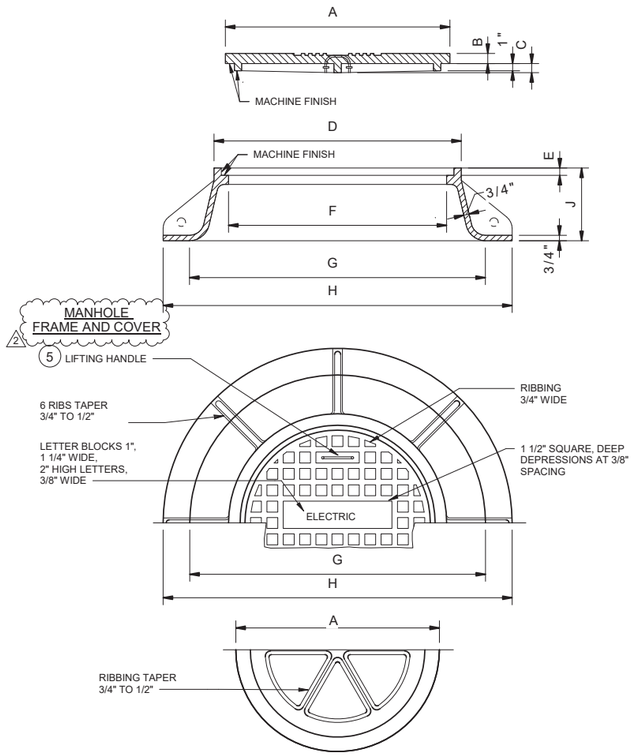


RACK HOOKS
L (in) 'A'
4.0
7.5
10.0
14.0
18.0

RACKS	
L (in) 'B'	NO. OF HOLES
15	8
24	14
30	18
48	24
55.25	37
64.25	43



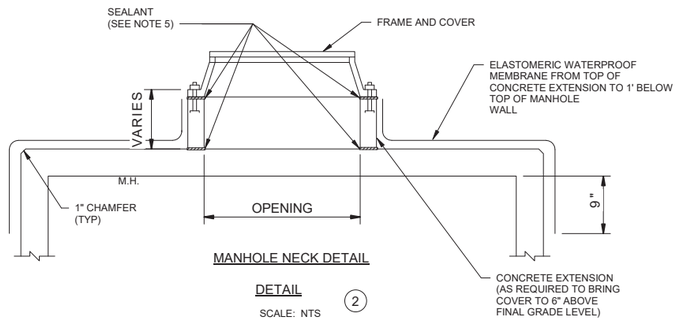
CABLE RACKS
DETAIL 1
SCALE: NTS



MANHOLE FRAME AND COVER 2

MANHOLE COVER & FRAME DIMENSIONS (INCHES) FOR DETAILS

A	B	C	D	E	F	G	H	J
31-7/8"	2"	3-1/4	32"	2"	30"	41"	49"	10"



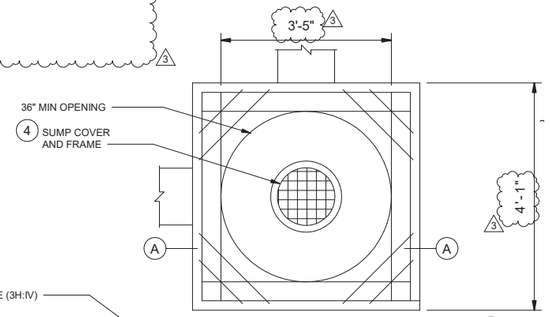
MANHOLE NECK DETAIL
DETAIL 2
SCALE: NTS

GENERAL NOTES:

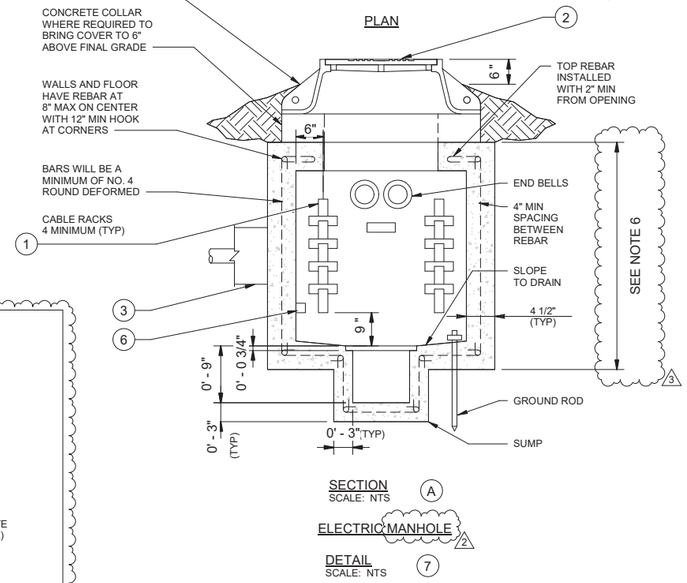
1. FOR ELECTRICAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS, SEE SHEETS E-001 THROUGH E-003.
2. THE COVER INSCRIPTION SHALL READ "ELECTRIC" ON ALL ELECTRICAL HANDHOLES.
3. ALL DIMENSIONS ARE MINIMUM REQUIREMENT FOR CONCRETE AND REBAR.
4. REINFORCING SHALL BE INCREASED WHERE REQUIRED TO SUIT ACTUAL INSTALLATION. MINIMUM REQUIREMENTS ARE FOR A H2O WHEEL LOADING (AASHTO).
5. JOINTS SHALL BE MADE WATERTIGHT USING A PLASTIC BITUMEN GASKET JOINT SEALANT. SEALANT SHALL MEET ASTM C990 AND BE IN STIP FORM WITH TWO SIDED REMOVABLE WRAPPER.
6. VERIFY DEPTH OF MANHOLES AND MANHOLE ENTRY/EXIT ELEVATIONS PRIOR TO CONSTRUCTION. REFER TO CIVIL PROFILE SHEETS FOR ELEVATIONS AND DEPTHS OF EACH MANHOLE.
7. BOTTOM OF VAULT SHALL BEAR ON 6" GRAVEL OVER PROPERLY COMPACTED SOIL.
8. REINFORCING SHOWN ON PLANS IS MAIN REINFORCING PER DETAILS. TRANSVERSE REINFORCING SHALL BE #4 @ 18" O.C.

SHEET KEYNOTES:

1. 2" ⌀ INSERT TYPICAL
2. #4 @ 12" O.C.
3. LADDER BY OTHERS

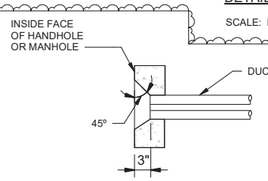


PLAN

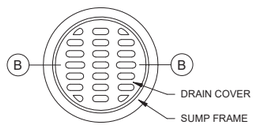


SECTION A
SCALE: NTS

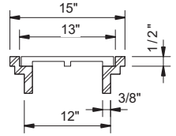
ELECTRIC MANHOLE 2
DETAIL 7
SCALE: NTS



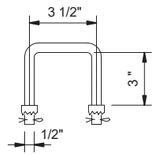
TYPICAL DUCT ENTRANCE
DETAIL 3
SCALE: NTS



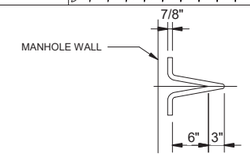
DETAIL 4
SCALE: NTS



TYPICAL SUMP FRAME
AND DRAIN COVER DETAIL
SECTION B
SCALE: NTS



COVER HANDLE
(2 HANDLES REQUIRED)
DETAIL 5
SCALE: NTS



PULLING-IN IRON
(PROVIDE ONE OPPOSITE
EACH DUCT ENTRANCE)
DETAIL 6
SCALE: NTS

A1 STANDARD MANHOLE DETAIL
NTS

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
4	AMENDMENT 0004	09/13/24
3	AMENDMENT 0003	08/23/24
2	AMENDMENT 0002	08/09/24

ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

DESIGNED BY: K. MANNING
DRAWN BY: J. WITHROW
CHECKED BY: M. MARTIN
APPROVED BY: C. PRZYGODA
SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE.
OVERLAND PARK, KS 66211

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CR/WU203004

STANDARD MANHOLE DETAIL

SHEET ID
E-507

READY-TO-ADVERTISE (RTA) SUBMITTAL

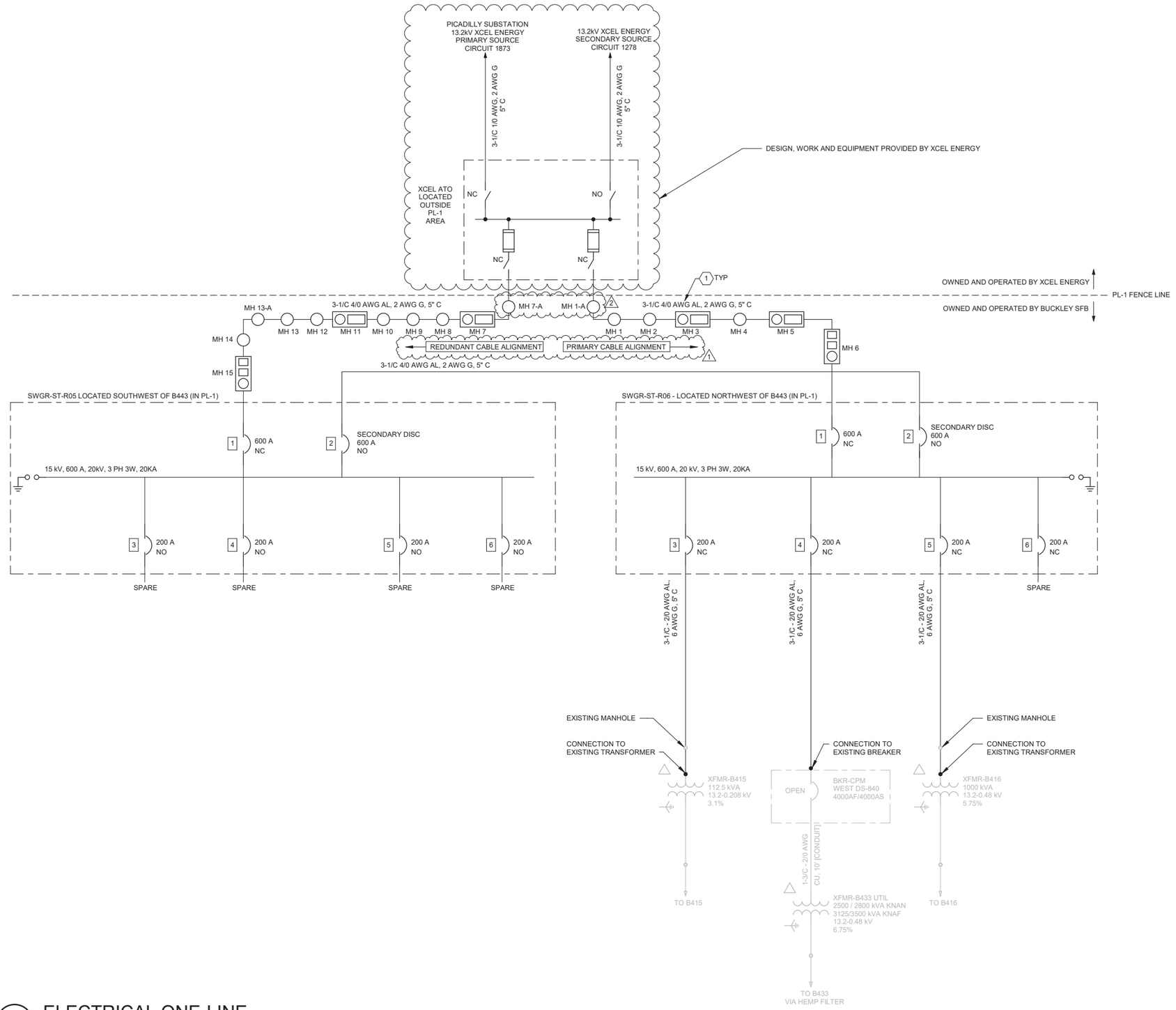
CUI

GENERAL NOTES:

1. FOR ELECTRICAL GENERAL NOTES, LEGEND, AND ABBREVIATIONS, SEE SHEETS E-001 THROUGH E-003.
2. XCEL ENERGY TO PROVIDE TWO 13.2 KVA POWER SOURCES AND ATO TO FEED THE NEW SWITCHGEAR IN PL-1. XCEL ENERGY TO DESIGN, PROCURE, INSTALL, AND MAINTAIN THE ATO.

SHEET KEYNOTES:

1. FOR UNDERGROUND CONDUIT INSTALLATION SEE DETAIL ON E-501.



A1 ELECTRICAL ONE-LINE
12" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE
2	AMENDMENT 0002	08/09/24
1	AMENDMENT 0001	07/30/24

DESIGNED BY: K. MANNING
DRAWN BY: J. WITHROW
CHECKED BY: M. MCKEES
ISSUE DATE: 07/03/2024
SOLICITATION NO.: W9128F24R0066
CONTRACT NO.: TBD

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA, NE 68102

BLACK AND VEATCH SPECIAL PROJECTS CORP
11401 LAMAR AVE.
OVERLAND PARK, KS 66211

SUBMITTED BY: C. PRZYGODA
SIZE: ANSI D

BUCKLEY SFB, CO
REDUNDANT ELECTRICAL SUPPLY
CRWU203004

ELECTRICAL ONE-LINE

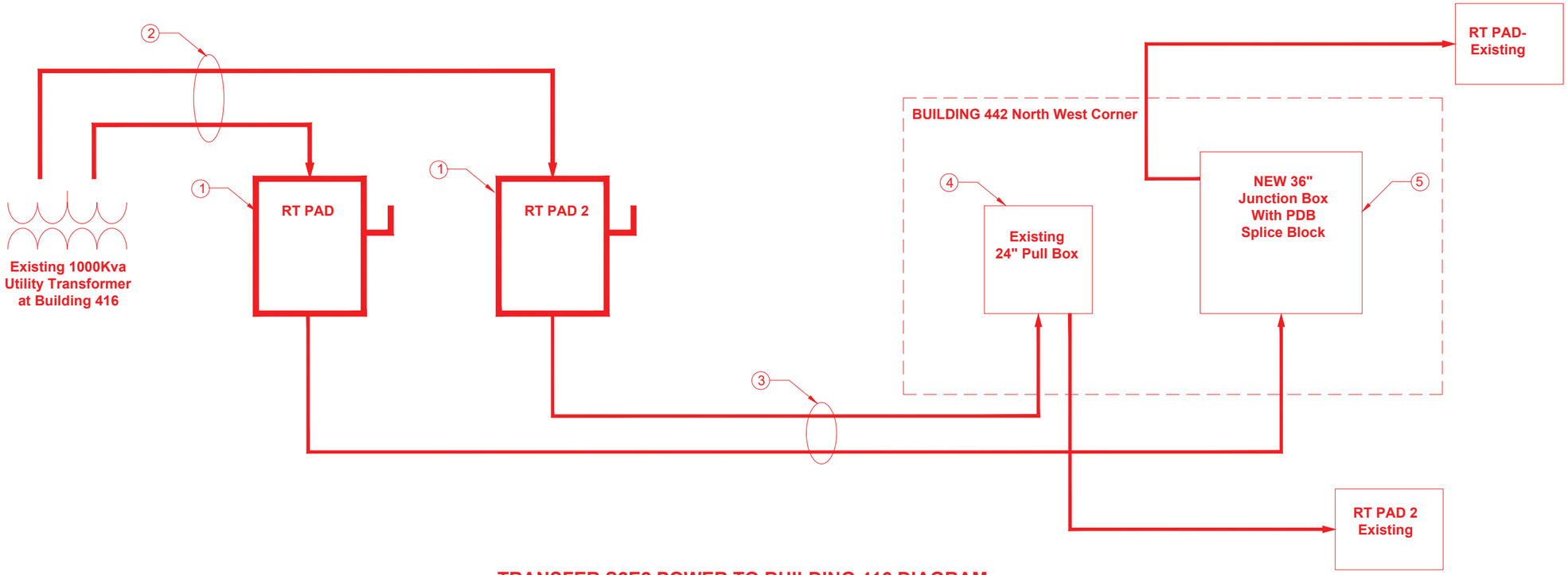
SHEET ID
E-601

READY-TO-ADVERTISE (RTA) SUBMITTAL

NEW Electric Lines
See Notes

NOTES:

1. Install (2) Sets of 4"PVC Schedule 80 in 12" deep trench cut into the asphalt.
2. Trench and conduits filled & covered with 3000 PSI concrete.
3. Conduits are surface exposed at rock area, shown here as White background.
4. Each conduit contains (3)Ea. #500MCM & (1)Ea. #2 ground.
5. Electrical connections at Building 442 were to existing conduits and wiring.
6. See additional sheet for more specifics on the electrical information.



TRANSFER S2E2 POWER TO BUILDING 416 DIAGRAM

NOTES:

1. New 400A 600V Fused Disconnects, NEMA 3R with FRS-R Fuses.
2. New 4" EMT Conduit W (3) Ea. #500 MCM & (1) Ea. #1/0 Ground. These conduits are above ground, exposed.
3. *New 4" Schedule 80 PVC conduits concrete encased at asphalt areas.
   *Exposed (Above Grade) at rock area.
   *Each conduit has (3) Ea. #500 MCM & (1) Ea. #2 ground.
4. Existing NEMA 3R Pull Box at B442. New Splices W insulated splicers connecting to existing wiring.
5. New 36" splice box at B442 W PDB connecting to existing wiring.

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04/06

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SECTION 33 82 00

TELECOMMUNICATIONS OUTSIDE PLANT (OSP)
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2023) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-87-640	(2023) Optical Fiber Outside Plant Communications Cable; 4th Edition
ICEA S-98-688	(2012) Broadband Twisted Pair Telecommunication Cable, Aircore, Polyolefin Insulated, Copper Conductors Technical Requirements
ICEA S-99-689	(2012) Broadband Twisted Pair Telecommunication Cable Filled, Polyolefin Insulated, Copper Conductors Technical Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-46A	(1990) FOTP-46 Spectral Attenuation Measurement for Long-Length, Graded-Index Optical Fibers
TIA-455-78-B	(2020c) FOTP-78 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures - Attenuation
TIA-455-107	(1999a) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Set
TIA-472D000	(2007b) Fiber Optic Communications Cable for Outside Plant Use
TIA-492CAAA	(1998; R 2002) Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers
TIA-526-7	(2015a; R 2022) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures - Part 4-2: Installed Cable Plant - Single-Mode Attenuation and Optical Return Loss Measurement
TIA-526-14	(2023d) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
TIA-568.2	(2018d) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568.3	(2022e) Optical Fiber Cabling Components Standard
TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces
TIA-590	(1997a) Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant
TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure
TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
TIA-758	(2012b) Customer-Owned Outside Plant

	Telecommunications Infrastructure Standard
TIA/EIA-455	(1998b) Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
TIA/EIA-455-204	(2000) Standard for Measurement of Bandwidth on Multimode Fiber
TIA/EIA-598	(2014D; Add 2 2018) Optical Fiber Cable Color Coding

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 1755	Telecommunications Standards and Specifications for Materials, Equipment and Construction
RUS Bull 345-50	(1979) Trunk Carrier Systems (PE-60)
RUS Bull 345-65	(1985) Shield Bonding Connectors (PE-65)
RUS Bull 345-72	(1985) Filled Splice Closures (PE-74)
RUS Bull 1751F-630	(1996) Design of Aerial Plant
RUS Bull 1751F-640	(1995) Design of Buried Plant, Physical Considerations
RUS Bull 1751F-643	(2002) Underground Plant Design
RUS Bull 1751F-815	(1979) Electrical Protection of Outside Plant
RUS Bull 1753F-201	(1997) Acceptance Tests of Telecommunications Plant (PC-4)
RUS Bull 1753F-401	(1995) Splicing Copper and Fiber Optic Cables (PC-2)

UL SOLUTIONS (UL)

UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape

1.2 RELATED REQUIREMENTS

Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEM, and Section 33 71 02, UNDERGROUND ELECTRICAL DISTRIBUTION apply to this section with additions and modifications specified herein.1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568.1, TIA-568.2,

TIA-568.3, TIA-569, TIA-606, and IEEE 100 and herein.

1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect - (MC).)

1.3.2 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.

1.3.3 Entrance Room (ER) (Telecommunications)

A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.3.4 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect - (IC).)

1.3.5 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 TELECOMMUNICATION SYSTEM DESCRIPTION

The telecommunications outside plant consists of cable, conduit, manholes, poles, etc. required to provide signal paths from the closest point of presence to the new facility, including free standing frames or backboards, interconnecting hardware, terminating cables, lightning and surge protection modules at the entrance facility. The work consists of providing, testing and making operational cabling, interconnecting hardware and lightning and surge protection necessary to form a complete outside plant telecommunications system for continuous use.

1.4.1 HEMP Penetration Description

This section covers the components, fabrications, installation, and testing for high-altitude electromagnetic pulse (HEMP) protection subsystems for Building 433 at Buckley Space Force Base. The HEMP protection subsystems to be provided by the Contractor on this project include, but are not be limited to, the following:

a. Waveguides below cutoff for HEMP protection at all fiber optic cable penetrations through HEMP shields.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL

PROCEDURES:

SD-01 Preconstruction Submittals

HEMP Protection Subsystem (Shielding) Specialist; G, RO

SD-02 Shop Drawings

HEMP Measures Shop Drawings; G, RO

Telecommunications Outside Plant; G, DO

Telecommunications Entrance Facility Drawings; G, DO

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Wire and Cable; G, DO

Cable Splices, and Connectors; G, DO

Closures; G, DO

Spare Parts; G, RO

Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required for certificates in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Pre-installation Tests; G, RO

Acceptance Tests; G, RO

Outside Plant Test Plan; G, RO

SD-07 Certificates

Telecommunications Contractor Qualifications; G, RO

Key Personnel Qualifications; G, RO

Minimum Manufacturer's Qualifications; G, RO

SD-08 Manufacturer's Instructions

Cable Tensions; G, RO

Fiber Optic Splices; G, RO

Submit instructions prior to installation.

SD-09 Manufacturer's Field Reports

Factory Reel Test Data; G, RO

SD-10 Operation and Maintenance Data

Telecommunications Outside Plant (OSP), Data Package 5; G, RO

Commercial off-the-shelf manuals shall be provided for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications outside plant (OSP). Submit operations and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data package 5, include the requirements of paragraphs TELECOMMUNICATIONS OUTSIDE PLANT SHOP DRAWINGS and TELECOMMUNICATIONS ENTRANCE FACILITY DRAWINGS.

SD-11 Closeout Submittals

Record Documentation; G, RO

In addition to other requirements, provide in accordance with paragraph RECORD DOCUMENTATION.

1.5.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawings

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Outside Plant Shop Drawings

Provide Outside Plant Design in accordance with TIA-758, RUS Bull 1751F-630 for aerial system design, and RUS Bull 1751F-643 for underground system design. Provide T0 shop drawings that show the physical and logical connections from the perspective of an entire campus, such as actual building locations, exterior pathways and campus backbone cabling on plan view drawings, major system nodes, and related connections on the logical system drawings in accordance with TIA-606. Drawings shall include wiring and schematic diagrams for fiber optic and copper cabling and splices, copper conductor gauge and pair count, fiber pair count and type, pathway

duct and innerduct arrangement, associated construction materials, and any details required to demonstrate that cable system has been coordinated and will properly support the switching and transmission system identified in specification and drawings. Provide Registered Communications Distribution Designer (RCDD) approved drawings of the telecommunications outside plant. The telecommunications outside plant (OSP) shop drawings shall be included in the operation and maintenance manuals.

1.6.1.2 Telecommunications Entrance Facility Drawings

Provide T3 drawings for EF Telecommunications as specified in the paragraph TELECOMMUNICATIONS SPACE DRAWINGS of Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEMS. The telecommunications entrance facility shop drawings shall be included in the operation and maintenance manuals.

1.6.2 Telecommunications Qualifications

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, the supervisor (if different from the installer), and the cable splicing and terminating personnel. A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor Qualifications

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems that include outside plant and broadband cabling within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems in accordance with TIA-758 within the past 3 years.

1.6.2.2 Key Personnel Qualifications

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Cable splicing and terminating personnel assigned to the installation of this system or any of its components shall have training in the proper techniques and have a minimum of 3 years experience in splicing and terminating the specified cables. Modular splices shall be performed by factory certified personnel or under direct supervision of factory trained personnel for products used.

Supervisors and installers assigned to the installation of this system or

any of its components shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products.

Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications outside plant systems, including broadband cabling, and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

1.6.2.3 Minimum Manufacturer's Qualifications

Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with, TIA-568.1, TIA-568.2 and TIA-568.3. In addition, cabling manufacturers shall have a minimum of 3 years experience in the manufacturing and factory testing of cabling which comply with ICEA S-87-640, ICEA S-98-688, and ICEA S-99-689.

1.6.3 Outside Plant Test Plan

Prepare and provide a complete and detailed test plan for field tests of the outside plant including a complete list of test equipment for the copper conductor and optical fiber cables, components, and accessories for approval by the Contracting Officer. Include a cut-over plan with procedures and schedules for relocation of facility station numbers without interrupting service to any active location. Submit the plan at least 30 days prior to tests for Contracting Officer approval. Provide outside plant testing and performance measurement criteria in accordance with TIA-568.1 and RUS Bull 1753F-201. Include procedures for certification, validation, and testing that includes fiber optic link

performance criteria.

1.6.3.1 PRE-CONSTRUCTION AND SPLICING INSPECTIONS

Notify Contracting Officer a minimum of 10 business days in advance of the Pre-Construction Inspection of the existing fiber optic and copper systems to which cutting and splicing are to be performed. Submit written findings, along with marked up drawings, using civil backgrounds, within five business days of the inspections.

In the presence of the Contracting Officer, perform a test of existing fiber optic and copper cables altered under this scope to determine and record any non-functional or damaged cable strands prior to construction. Any damage or loss of function shown to have occured during construction must be repaired by the Contractor at no expense to the Goverment.

In the presence of the Contracting Officer, after splicing cuts are made but before splicing of new cable into the existing system, perform a test of existing fiber optic and copper cables to remain in service and spliced to new cables to determine and record the location of any non-functional or damaged cable strands prior to splicing. Any damage or loss of function shown to have occured during construction must be repaired by the Contractor at no expense to the Goverment.

Contractor shall coordinate with COR and the communications squadron (5CS) to identify node locations and test points at each end of the altered cable.

1.6.4 Standard Products

Provide materials and equipment that are standard products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and shall be the manufacturer's latest standard design that has been in satisfactory commercial or industrial use for at least 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Products supplied shall be specifically designed and manufactured for use with outside plant telecommunications systems. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is provided.

1.6.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.5.1 Independent Testing Organization Certificate

In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.7 DELIVERY, STORAGE, AND HANDLING

Ship cable on reels in 1000 feet length with a minimum overage of 10 percent. Radius of the reel drum shall not be smaller than the minimum bend radius of the cable. Wind cable on the reel so that unwinding can be done without kinking the cable. Two meters of cable at both ends of the cable shall be accessible for testing. Attach permanent label on each reel showing length, cable identification number, cable size, cable type, and date of manufacture. Provide water resistant label and the indelible writing on the labels. Apply end seals to each end of the cables to prevent moisture from entering the cable. Reels with cable shall be suitable for outside storage conditions when temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 100 percent. Equipment, other than cable, delivered and placed in storage shall be stored with protection from weather, humidity and temperature variation, dirt and dust, or other contaminants in accordance with manufacturer's requirements.

1.8 MAINTENANCE

1.8.1 Record Documentation

Provide the activity responsible for telecommunications system maintenance and administration a single complete and accurate set of record documentation for the entire telecommunications system with respect to this project.

Provide record documentation as specified in Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

1.8.2 Spare Parts

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking. Spare parts shall be provided no later than the start of field testing.

1.9 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Products supplied shall be specifically designed and manufactured for use with outside plant telecommunications systems.

2.2 TELECOMMUNICATIONS ENTRANCE FACILITY

2.2.1 Fiber Optic Terminations

Provide fiber optic cable terminations as specified in 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.3 CLOSURES

2.3.1 Copper Conductor Closures

2.3.1.1 Underground Cable Closures

a. Aboveground: Provide aboveground closures constructed of not less than 14 gauge steel and acceptable for stake mounting in accordance with RUS 1755.910. Closures shall be sized and contain a marker as indicated. Covers shall be secured to prevent unauthorized entry.

b. In vault or manhole: Provide underground closure suitable to house a straight, butt, and branch splice in a protective housing into which can be poured an encapsulating compound. Closure shall be of suitable thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Encapsulating compound shall be reenterable and shall not alter the chemical stability of the closure. Provide filled splice cases in accordance with RUS Bull 345-72.

2.3.2 Fiber Optic Closures

2.3.2.1 Aerial

There is no aerial fiber optic installation in this project.

2.3.2.2 In Vault or Manhole

Provide underground closure suitable to house splice organizer in a protective housing into which can be poured an encapsulating compound. Closure shall be of thermoplastic, thermoset, or stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or manhole environment. Encapsulating compound shall be reenterable and shall not alter the chemical stability of the closure.

2.4 CABLE SPLICES, AND CONNECTORS

2.4.1 Copper Cable Splices

Provide multipair, foldback single pair, splices of a moisture resistant, two-wire insulation displacement connector held rigidly in place to assure maximum continuity in accordance with RUS Bull 1753F-401. Cables greater than 25 pairs shall be spliced using multipair splicing connectors, which accommodate 25 pairs of conductors at a time. Provide correct connector size to accommodate the cable gauge of the supplied cable.

2.4.2 Copper Cable Splice Connector

Provide splice connectors with a polycarbonate body and cap and a tin-plated brass contact element. Connector shall accommodate 22 to 26 AWG solid wire with a maximum insulation diameter of 0.065 inch. Fill connector with sealant grease to make a moisture resistant connection, in accordance with RUS Bull 1753F-401.

2.4.3 Fiber Optic Cable Splices

Where permitted, provide fiber optic cable splices and splicing materials for fusion methods at locations shown on the construction drawings. Perform splices in areas where temperature, humidity, and cleanliness can be controlled in accordance with RUS Bull 1753F-401. The splice insertion loss shall be 0.3 dB maximum when measured in accordance with TIA-455-78-B using an Optical Time Domain Reflectometer (OTDR). Splices shall be designed for a return loss of 40.0 db max for single mode fiber when tested in accordance with TIA-455-107. Physically protect each fiber optic splice by a splice kit specially designed for the splice.

2.4.4 Fiber Optic Splice Organizer

Provide splice organizer suitable for housing fiber optic splices in a neat and orderly fashion. Splice organizer shall allow for a minimum of 3 feet of fiber for each fiber within the cable to be neatly stored without kinks or twists. Splice organizer shall accommodate individual strain relief for each splice and allow for future maintenance or modification, without damage to the cable or splices. Provide splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors in a splice organizer kit.

2.4.5 Shield Connectors

Provide connectors with a stable, low-impedance electrical connection between the cable shield and the bonding conductor in accordance with RUS Bull 345-65.

2.5 CONDUIT

Provide conduit as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.6 PLASTIC INSULATING TAPE

UL 510.

2.7 WIRE AND CABLE

2.7.1 Copper Conductor Cable

Solid copper conductors, covered with an extruded solid insulating compound. Insulated conductors shall be twisted into pairs which are then stranded or oscillated to form a cylindrical core. For special high frequency applications, the cable core shall be separated into compartments. Cable shall be completed by the application of a suitable core wrapping material, a corrugated copper or plastic coated aluminum shield, and an overall extruded jacket. Telecommunications contractor shall verify distances between splice points prior to ordering cable in specific cut lengths. Gauge of conductor shall determine the range of numbers of pairs specified; 19 gauge (6 to 400 pairs), 22 gauge (6 to 1200 pairs), 24 gauge (6 to 2100 pairs), and 26 gauge (6 to 3000 pairs). Copper conductor shall conform to the following:

2.7.1.1 Underground

Provide filled cable meeting the requirements of ICEA S-99-689 and RUS 1755.390 .

2.7.2 Fiber Optic Cable

Provide single-mode, 8/125-um, 0.10 aperture 1310 nm armored fiber optic cable in accordance with TIA-492CAAA, TIA-472D000, and ICEA S-87-640 including any special requirements made necessary by a specialized design. Provide optical fibers as indicated. Fiber optic cable shall be specifically designed for outside use with loose buffer construction. Provide fiber optic color code in accordance with TIA/EIA-598

2.7.2.1 Strength Members

Provide central, non-metallic strength members with sufficient tensile strength for installation and residual rated loads to meet the applicable performance requirements in accordance with ICEA S-87-640. The strength member is included to serve as a cable core foundation to reduce strain on the fibers, and shall not serve as a pulling strength member.

2.7.2.2 Performance Requirements

Provide fiber optic cable with optical and mechanical performance requirements in accordance with ICEA S-87-640.

2.7.3 Grounding and Bonding Conductors

Provide grounding and bonding conductors in accordance with RUS 1755.200, TIA-607, IEEE C2, and NFPA 70. Solid bare copper wire meeting the requirements of ASTM B1 for sizes No. 8 AWG and smaller and stranded bare copper wire meeting the requirements of ASTM B8, for sizes No. 6 AWG and larger. Insulated conductors shall have 600-volt, Type TW insulation meeting the requirements of UL 83.

2.8 T-SPAN LINE TREATMENT REPEATERS

Provide as indicated. Repeaters shall be pedestal mounted with non-pressurized housings, sized as indicated and shall meet the requirements of RUS Bull 345-50.

2.9 HEMP Shielding and Penetrations

This section covers the components, fabrications, installation, and testing for high-altitude electromagnetic pulse (HEMP) protection subsystems. The HEMP protection subsystems to be provided by the Contractor on this project include, but are not be limited to, the following:

a. Waveguides below cutoff for HEMP protection at all fiber optic cable penetrations through HEMP shields.

2.9.1 Supervision by HEMP Protection Subsystem (Shielding) Specialist

The HEMP protection subsystems shall be provided by a HEMP protection subsystem (shielding) specialist, approved by the Contracting Officer. The shielding specialist shall be an experienced firm which has been regularly and successfully engaged in the manufacturing, installation, and supervision of equivalent HEMP shielded systems.

2.9.2 HEMP Measures Shop Drawings

Shop drawings for the HEMP shielded enclosure, including all shield penetrations and penetration protection devices and treatments, shall be prepared by the Contractor and HEMP protection specialist, and submitted to the Contracting Officer for approval before shield assembly and installation is commenced. The drawings shall provide a complete list of materials and parts, sizes, arrangements, and the methods and sequence of assembly. Layouts of the shield plates, details for welding the seams and joints, connections to structural members, and all other attachments to the shield shall be detailed. The number and locations of penetrations and the method of HEMP protection at each penetration shall be shown. Hardness critical items and hardness critical processes shall be identified on the drawings with HCI and HCP symbols, respectively, per MIL-STD-188-125-1 and MIL-HDBK-423.

2.9.3 Penetration Plates

Penetration plates shall be used for treatment of penetrations of the HEMP shield. The plates shall be constructed of ASTM A 36/A 36M steel plate welded to the shield or as shown on drawings. Waveguide, conduit, and piping penetrations shall be circumferentially welded at the point of penetration to the inner surface of the penetration plate. Penetration plates shall extend at least 6 inches beyond all penetrations, unless otherwise detailed on HEMP design drawings, based upon reference HEMP details included in design documents. Plate penetration devices shall be shop fabricated, unless otherwise indicated.

2.9.4 Test Penetrations

Two capped N-type bulkhead feedthrough connectors shall be mounted to the barrier between the two compartments for use in performing pulsed current injection testing.

2.9.5 Waveguide Assemblies

Waveguide-below-cutoff (WBC) protection shall be provided for all HVAC, piping, plumbing and fiber optic cable penetrations of the HEMP shields as required. These WBC penetration protection devices shall have transverse dimensions such that the waveguide cutoff frequency is at least 1.5 GHz.

The lengths of the WBC shall be at least five times the cross-sectional diameter for circular waveguides and at least five times the diagonal cross-sectional cell dimension for rectangular waveguides. No conductors (electrical wiring, louver operating rods, fiber optic cable metallic strength members or shields, pipes or hoses with metallic components, etc.) shall be permitted to pass through the WBC. A non-conductive pipe, hose or dielectric lining is not permitted to be installed within the WBC.

2.9.6 Fiber Optic Cable Waveguide Assemblies

Each fiber optic cable WBC shall have an inside diameter that does not exceed 4 inches and shall be of the size shown in the HEMP design drawings, based upon reference HEMP details included in design documents. The length of the waveguide section shall be at least five times the inside diameter. The WBC section shall be circumferentially welded to a penetration plate that shall have a minimum thickness of 1/4 inch and a width sufficient to ensure that the WBC is not damaged when the penetration plate is welded to the shield. The end of the fiber optic WBC shall be filled with a dielectric material or otherwise capped to prevent inadvertent insertion of conductors.

2.9.7 Waveguide Installation

Penetrations of the HEMP shield shall be treated with the appropriate waveguide method. Waveguides shall be suitable for piping and for fluids or gases contained within, in accordance with specified requirements.

2.9.8 Fiber Optic Cable Waveguide Installation Quality Control

The quality control program for installation of ventilation, piping, and fiber optic cable waveguide-below-cutoff penetration protective devices shall include in-progress primary shield weld inspections and testing of waveguide-to-penetration plate and penetration plate-to-HEMP shield welds joining the protective devices to the facility HEMP shields and all other hardness critical welds. It shall also include preliminary shielding effectiveness testing and shielding effectiveness acceptance testing. Results of quality control inspections and tests on the waveguide protective device installations shall be reported to the Contracting Officer in the Daily HEMP QC Reports.

2.10 CABLE TAGS IN MANHOLES, HANDHOLES, AND VAULTS

Provide tags for each telecommunications cable or wire located in manholes, handholes, and vaults. Cable tags shall be polyethylene and labeled in accordance with TIA-606. Handwritten labeling is unacceptable.

2.10.1 Polyethylene Cable Tags

Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties shall have a minimum loop tensile strength of 175 pounds. The cable tags shall have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags' orientation.

2.11 BURIED WARNING AND IDENTIFICATION TAPE

Provide fiber optic media marking and protection in accordance with TIA-590. Provide color, type and depth of tape as specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 00 00, EARTHWORK.

2.12 GROUNDING BRAID

Provide grounding braid that provides low electrical impedance connections for dependable shield bonding in accordance with RUS 1755.200. Braid shall be made from flat tin-plated copper.

2.13 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.14 FIELD FABRICATED NAMEPLATES

Provide laminated plastic nameplates in accordance with ASTM D709 for each patch panel, protector assembly, rack, cabinet and other equipment or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.15 TESTS, INSPECTIONS, AND VERIFICATIONS

2.15.1 Factory Reel Test Data

Test 100 percent OTDR test of FO media at the factory in accordance with TIA-568.1 and TIA-568.3. Use TIA-526-7 for single mode fiber and TIA-526-14 Method B for multi mode fiber measurements. Calibrate OTDR to show anomalies of 0.2 dB minimum. Enhanced performance filled OSP copper cables, referred to as Broadband Outside Plant (BBOSP), shall meet the requirements of ICEA S-99-689. Enhanced performance air core OSP copper cables shall meet the requirements of ICEA S-98-688. Submit test reports, including manufacture date for each cable reel and receive approval before delivery of cable to the project site.

2.15.2 Verification

Before, during, and after the HEMP shielding and penetration protection subsystem installation, the HEMP protection specialist shall verify and approve the installation for compliance with the specifications. Materials and methods, shop drawings, and other items for the shielding subsystem shall be approved by the HEMP protection specialist and by the Contracting Officer.

2.15.3 Inspection

During and after HEMP shielding and penetration protection subsystem installation a qualified quality control inspector shall inspect the installation for compliance with the specifications. The qualified quality control inspector shall be furnished by the HEMP Protection Specialist.

2.15.4 Facility Shielding Effectiveness Acceptance Test Plan and Procedures

A detailed test plan and procedures for shielding effectiveness acceptance testing of the HEMP shields and penetration protection devices shall be submitted to the Contracting Officer for approval at least 30 days before the scheduled start of testing. The test plan and procedures document shall comply with the requirements in Appendix A to MIL-STD-188-125-1. Contents shall include, but not be limited to, a statement of test objectives; shielded enclosure identification and descriptions; test area and test point identifications; identification of test frequencies; test equipment identification; detailed calibration and measurement procedures; procedures for marking, repair, and retest of defects; deviations from the test requirements of the standard; data management; format and outline of the test report to be provided; safety; security (if applicable); and schedule.

2.15.5 Acceptance Test Points

For testing in the HEMP frequency range numbered test points shall be established at all architectural, mechanical, and electrical shield penetrations. The measurement axes for test points shall be normal to the shield surface at the geometric centers of shielded doors, equipment access panels (less than 10 feet x 10 feet in area), and ventilation waveguide-below cutoff panels and at the centerlines of penetrating pipes or conduits for piping and electrical penetrations. Groupings of penetrations with a 2 feet radius shall only require one test point for the penetration group.

2.15.6 Facility Pulsed Current Injection (PCI) Acceptance Test Plan and Procedures

A detailed test plan and procedures for pulsed current injection acceptance testing of filter/ESA penetration protective devices on electrical penetrations of the facility HEMP shield shall be submitted to the Contracting Officer for approval at least 30 days before the scheduled start of testing. The test plan and procedures document shall comply with the requirements in Appendix B to MIL-STD-188-125-1. Contents shall include, but not be limited to, a statement of test objectives; facility identification and descriptions; identification of penetration protective devices to be tested, identification of test points and injection levels; test equipment identification; detailed calibration and measurement procedures; deviations from the test requirements of the standard; data management; format and outline of the test report to be provided; safety; security (if applicable); and schedule.

2.15.7 Pulsed Current Injection Acceptance Test Method

After completion of the HEMP shield and after installation of penetration protective devices, equipment, and finish work provided under the construction contract, PCI acceptance testing shall be conducted. The required PCI acceptance test method involves coupling of threat-relatable transients at injection points outside the facility HEMP shield. Only injections in individual wire-to-ground configurations are required. Injected transients include short (E1 HEMP-induced), intermediate (E2 HEMP-induced), and long (E3 HEMP-induced) pulses, depending upon the class of electrical penetration. Residual internal transients are measured at test points inside the shield. Norms of the residual internal response waveforms are determined and compared to maximum allowable norm limits.

Operation of the protective devices are also observed and checked to ensure that they have not been damaged or degraded by the injected transients. Pass/fail criteria are provided in Appendix B to MIL-STD-188-125-1.

2.15.8 PCI Test Failures

If the transient suppression/attenuation performance of any filter/ESA assembly fails to satisfy the pass/fail criteria in Appendix B to MIL-STD-188-125-1, the defect shall be repaired and the PCI test procedure shall be repeated on the applicable penetration protective device.

PART 3 EXECUTION

3.1 INSTALLATION

Install all system components and appurtenances in accordance with manufacturer's instructions IEEE C2, NFPA 70, and as indicated. Provide all necessary interconnections, services, and adjustments required for a complete and operable telecommunications system.

3.1.1 Contractor Damage

Promptly repair indicated utility lines or systems damaged during site preparation and construction. Damages to lines or systems not indicated, which are caused by Contractor operations, shall be treated as "Changes" under the terms of the Contract Clauses. When Contractor is advised in writing of the location of a nonindicated line or system, such notice shall provide that portion of the line or system with "indicated" status in determining liability for damages. In every event, immediately notify the Contracting Officer of damage.

3.1.2 Cable Inspection and Repair

Handle cable and wire provided in the construction of this project with care. Inspect cable reels for cuts, nicks or other damage. Damaged cable shall be replaced or repaired to the satisfaction of the Contracting Officer. Reel wraps shall remain intact on the reel until the cable is ready for placement.

3.1.3 Direct Burial System

Installation shall be in accordance with RUS Bull 1751F-640. Under railroad tracks, paved areas, and roadways install cable in conduit encased in concrete. Slope ducts to drain. Excavate trenches by hand or mechanical trenching equipment. Provide a minimum cable cover of 24 inches below finished grade. Trenches shall be not less than 6 inches wide and in straight lines between cable markers. Do not use cable plows. Bends in trenches shall have a radius of not less than 36 inches. Where two or more cables are laid parallel in the same trench, space laterally at least 3 inches apart. When rock is encountered, remove it to a depth of at least 3 inches below the cable and fill the space with sand or clean earth free from particles larger than 1/4 inch. Do not unreel and pull cables into the trench from one end. Cable may be unreeled on grade and lifted into position. Provide color, type and depth of warning tape as specified in paragraph BURIED WARNING AND IDENTIFICATION TAPE in Section 31 00 00 EARTHWORK.

3.1.3.1 Cable Placement

a. Separate cables crossing other cables or metal piping from the other cables or pipe by not less than 3 inches of well tamped earth. Do not install circuits for communications under or above traffic signal loops.

b. Cables shall be in one piece without splices between connections except where the distance exceeds the lengths in which the cable is furnished.

c. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

d. Leave a horizontal slack of approximately 3 feet in the ground on each end of cable runs, on each side of connection boxes, and at points where connections are brought aboveground. Where cable is brought aboveground, leave additional slack to make necessary connections.

3.1.3.2 Identification Slabs Markers

Provide a marker at each change of direction of the cable, over the ends of ducts or conduits which are installed under paved areas and roadways and over each splice. Identification markers shall be of concrete, approximately 20 inches square by 6 inches thick.

3.1.3.3 Backfill for Rocky Soil

When placing cable in a trench in rocky soil, the cable shall be cushioned by a fill of sand or selected soil at least 2 inches thick on the floor of the trench before placing the cable or wire. The backfill for at least 4 inches above the wire or cable shall be free from stones, rocks, or other hard or sharp materials which might damage the cable or wire. If the buried cable is placed less than 24 inches in depth, a protective cover of concrete shall be used.

3.1.4 Cable Protection

Provide direct burial cable protection in accordance with NFPA 70 and as specified in Section 33 71 02 EXTERIOR ELECTRICAL DISTRIBUTION (SITE ELECTRICAL SCOPE #?). Galvanized conduits which penetrate concrete (slabs, pavement, and walls) shall be PVC coated and shall extend from the first coupling or fitting outside either side of the concrete minimum of 6 inches per 12 inches burial depth beyond the edge of the surface where cable protection is required; all conduits shall be sealed on each end. Where additional protection is required, cable may be placed in galvanized iron pipe (GIP) sized on a maximum fill of 40 percent of cross-sectional area, or in concrete encased 4 inches PVC pipe. Conduit may be installed by jacking or trenching. Trenches shall be backfilled with earth and mechanically tamped at 6 inches lift so that the earth is restored to the same density, grade and vegetation as adjacent undisturbed material.

3.1.4.1 Cable End Caps

Cable ends shall be sealed at all times with coated heat shrinkable end caps. Cables ends shall be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps shall remain in place until the cable is spliced or terminated.

Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

3.1.5 Underground Duct

Provide underground duct and connections to existing manholes, handholes, concrete pads, and existing ducts as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION with any additional requirements as specified herein.

3.1.6 Reconditioning of Surfaces

Provide reconditioning of surfaces as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.1.7 Penetrations

Caulk and seal cable access penetrations in walls, ceilings and other parts of the building. Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings in accordance with Section 07 84 00 FIRESTOPPING.

3.1.8 Cable Pulling

Test duct lines with a mandrel and swab out to remove foreign material before the pulling of cables. Avoid damage to cables in setting up pulling apparatus or in placing tools or hardware. Do not step on cables when entering or leaving the manhole. Do not place cables in ducts other than those shown without prior written approval of the Contracting Officer. Roll cable reels in the direction indicated by the arrows painted on the reel flanges. Set up cable reels on the same side of the manhole as the conduit section in which the cable is to be placed. Level the reel and bring into proper alignment with the conduit section so that the cable pays off from the top of the reel in a long smooth bend into the duct without twisting. Under no circumstances shall the cable be paid off from the bottom of a reel. Check the equipment set up prior to beginning the cable pulling to avoid an interruption once pulling has started. Use a cable feeder guide of suitable dimensions between cable reel and face of duct to protect cable and guide cable into the duct as it is paid off the reel. As cable is paid off the reel, lubricate and inspect cable for sheath defects. When defects are noticed, stop pulling operations and notify the Contracting Officer to determine required corrective action. Cable pulling shall also be stopped when reel binds or does not pay off freely. Rectify cause of binding before resuming pulling operations. Provide cable lubricants recommended by the cable manufacturer. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.

3.1.8.1 Cable Tensions

Obtain from the cable manufacturer and provide to the Contracting Officer, the maximum allowable pulling tension. This tension shall not be exceeded.

3.1.8.2 Pulling Eyes

Equip cables 1.25 inches in diameter and larger with cable manufacturer's factory installed pulling-in eyes. Provide cables with diameter smaller

than 1.25 inches with heat shrinkable type end caps or seals on cable ends when using cable pulling grips. Rings to prevent grip from slipping shall not be beaten into the cable sheath. Use a swivel of 3/4 inch links between pulling-in eyes or grips and pulling strand.

3.1.8.3 Installation of Cables in Manholes, Handholes, and Vaults

Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support cables on brackets and cable insulators at a maximum of 4 feet. In existing manholes, handholes, and vaults where new ducts are to be terminated, or where new cables are to be installed, modify the existing installation of cables, cable supports, and grounding as required with cables arranged and supported as specified for new cables. Identify each cable with corrosion-resistant embossed metal tags.

3.1.9 Cable Splicing

3.1.9.1 Copper Conductor Splices

Perform splicing in accordance with requirements of RUS Bull 1753F-401 except that direct buried splices and twisted and soldered splices are not allowed. Exception does not apply for pairs assigned for carrier application.

3.1.9.2 Fiber Optic Splices

Where permitted, fiber optic splicing shall be in accordance with manufacturer's recommendation and shall exhibit an insertion loss not greater than 0.2 dB for fusion splices.

3.1.10 Surge Protection

All cables and conductors, except fiber optic cable, which serve as communication lines through off-premise lines, shall have surge protection installed at each end which meet the requirements of RUS Bull 1751F-815.

3.1.11 Grounding

Provide grounding and bonding in accordance with RUS 1755.200, TIA-607, IEEE C2, and NFPA 70. Ground exposed noncurrent carrying metallic parts of telephone equipment, cable sheaths, cable splices, and terminals.

3.1.11.1 Telecommunications Master Ground Bar (TMGB)

The TMGB is the hub of the basic telecommunications grounding system providing a common point of connection for ground from outside cable, CD, and equipment. Establish a TMGB for connection point for cable stub shields to connector blocks and CD protector assemblies as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.1.11.2 Incoming Cable Shields

Shields shall not be bonded across the splice to the cable stubs. Ground shields of incoming cables in the EF Telecommunications to the TMGB.

3.1.11.3 Campus Distributor Grounding

a. Protection assemblies: Mount CD protector assemblies directly on the telecommunications backboard. Connect assemblies mounted on each vertical frame with No. 6 AWG copper conductor to provide a low resistance path to TMGB.

b. TMGB connection: Connect TMGB to TGB with copper conductor with a total resistance of less than 0.01 ohms.

3.1.12 Cut-Over

All necessary transfers and cut-overs, shall be accomplished by the telecommunications contractor.

3.2 Miscellaneous Shielding Penetration Installation

HEMP shield penetrations, other than those listed in the penetration schedule on the approved shop drawings, shall not be made without the prior written approval of the Contracting Officer.

3.3 Facility Hemp Shielding Enclosure Installation

The facility HEMP shielded enclosure shall be installed in accordance with this specification, the HEMP design drawings, based upon reference HEMP details included in design documents, and the recommendations of the manufacturer and HEMP protection specialist. Shielding steel shall be handled and installed without damage to the shielding steel. Penetration protective devices shall be installed in accordance with the approved shop drawings and penetration schedules. No other penetrations including fasteners and mounting bolts, shall be permitted without prior written authorization from the Contracting Officer. All elements shall be protected from corrosion until they are installed and paint system is complete.

3.4 LABELING

3.4.1 Labels

Provide labeling for new cabling and termination hardware located within the facility in accordance with TIA-606. Handwritten labeling is unacceptable. Stenciled lettering for cable and termination hardware shall be provided using laser printer.

3.4.2 Cable Tag Installation

Install cable tags for each telecommunications cable or wire located in manholes, handholes, and vaults including each splice. Tag new wire and cable provided under this contract and existing wire and cable which are indicated to have splices and terminations provided by this contract. The labeling of telecommunications cable tag identifiers shall be in accordance with TIA-606. Do not provide handwritten letters. Install cable tags so that they are clearly visible without disturbing any cabling or wiring in the manholes, handholes, and vaults.

3.4.3 Termination Hardware

Label patch panels, distribution panels, connector blocks and protection modules using color coded labels with identifiers in accordance with

TIA-606.

3.5 FIELD APPLIED PAINTING

Provide ferrous metallic enclosure finishes in accordance with the following procedures. Ensure that surfaces are dry and clean when the coating is applied. Coat joints and crevices. Prior to assembly, paint surfaces which will be concealed or inaccessible after assembly. Apply primer and finish coat in accordance with the manufacturer's recommendations.Provide ferrous metallic enclosure finishes as specified in Section 09 90 00 PAINTS AND COATINGS.

3.5.1 Cleaning

Clean surfaces in accordance with SSPC SP 6/NACE No.3.

3.5.2 Priming

Prime with a two component polyamide epoxy primer which has a bisphenol-A base, a minimum of 60 percent solids by volume, and an ability to build up a minimum dry film thickness on a vertical surface of 5.0 mils. Apply in two coats to a total dry film thickness of 5 to 8 mils.

3.5.3 Finish Coat

Finish with a two component urethane consisting of saturated polyester polyol resin mixed with aliphatic isocyanate which has a minimum of 50 percent solids by volume. Apply to a minimum dry film thickness of 2 to 3 mils. Color shall be the manufacturer's standard.

3.6 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.7 FIELD QUALITY CONTROL

Provide the Contracting Officer 10 working days notice prior to each test. Provide labor, equipment, and incidentals required for testing. Correct defective material and workmanship disclosed as the results of the tests. Furnish a signed copy of the test results to the Contracting Officer within 3 working days after the tests for each segment of construction are completed. Perform testing as construction progresses and do not wait until all construction is complete before starting field tests.

3.7.1 Pre-Installation Tests

Perform the following tests on cable at the job site before it is removed from the cable reel. For cables with factory installed pulling eyes, these tests shall be performed at the factory and certified test results shall accompany the cable.

3.7.1.1 Cable Capacitance

Perform capacitance tests on at least 10 percent of the pairs within a cable to determine if cable capacitance is within the limits specified.

3.7.1.2 Loop Resistance

Perform DC-loop resistance on at least 10 percent of the pairs within a cable to determine if DC-loop resistance is within the manufacturer's calculated resistance.

3.7.1.3 Pre-Installation Test Results

Provide results of pre-installation tests to the Contracting Officer at least 5 working days before installation is to start. Results shall indicate reel number of the cable, manufacturer, size of cable, pairs tested, and recorded readings. When pre-installation tests indicate that cable does not meet specifications, remove cable from the job site.

3.7.2 Acceptance Tests

Perform acceptance testing in accordance with RUS Bull 1753F-201 and as further specified in this section. Provide personnel, equipment, instrumentation, and supplies necessary to perform required testing. Notification of any planned testing shall be given to the Contracting Officer at least 14 days prior to any test unless specified otherwise. Testing shall not proceed until after the Contractor has received written Contracting Officer's approval of the test plans as specified. Test plans shall define the tests required to ensure that the system meets technical, operational, and performance specifications. The test plans shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested. Provide test reports in booklet form showing all field tests performed, upon completion and testing of the installed system. Measurements shall be tabulated on a pair by pair or strand by strand basis.

3.7.2.1 Copper Conductor Cable

Perform the following acceptance tests in accordance with TIA-758:

a. Wire map (pin to pin continuity)

b. Continuity to remote end

c. Crossed pairs

d. Reversed pairs

e. Split pairs

f. Shorts between two or more conductors

3.7.2.2 Fiber Optic Cable

Test fiber optic cable in accordance with TIA/EIA-455 and as further specified in this section. Two optical tests shall be performed on all optical fibers: Optical Time Domain Reflectometry (OTDR) Test, and Attenuation Test. In addition, a Bandwidth Test shall be performed on all multimode optical fibers. These tests shall be performed on the completed end-to-end spans which include the near-end pre-connectorized single fiber cable assembly, outside plant as specified, and the far-end pre-connectorized single fiber cable assembly.

a. OTDR Test: The OTDR test shall be used to determine the adequacy of the cable installations by showing any irregularities, such as discontinuities, micro-bendings or improper splices for the cable span under test. Hard copy fiber signature records shall be obtained from the OTDR for each fiber in each span and shall be included in the test results. The OTDR test shall be measured in both directions. A reference length of fiber, 66 feet minimum, used as the delay line shall be placed before the new end connector and after the far end patch panel connectors for inspection of connector signature. Conduct OTDR test and provide calculation or interpretation of results in accordance with TIA-526-7 for single-mode fiber and TIA-526-14 for multimode fiber. Splice losses shall not exceed 0.3 db.

b. Attenuation Test: End-to-end attenuation measurements shall be made on all fibers, in both directions, using a 1310 and 1550 nanometer light source at one end and the optical power meter on the other end to verify that the cable system attenuation requirements are met in accordance with TIA-455-46A for multimode and TIA-526-7 for single-mode fiber optic cables. The measurement method shall be in accordance with TIA-455-78-B. Attenuation losses shall not exceed 0.5 db/km at 1310 nm and 1550 nm for single-mode fiber. Attenuation losses shall not exceed 5.0 db/km at 850 nm and 1.5 db/km at 1300 nm for multimode fiber.

c. Bandwidth Test: The end-to-end bandwidth of all multimode fiber span links shall be measured by the frequency domain method. The bandwidth shall be measured in both directions on all fibers. The bandwidth measurements shall be in accordance with TIA/EIA-455-204.

3.7.3 Soil Density Tests

b. Determine soil-density relationships as specified for soil tests in Section 31 00 00 EARTHWORK.

3.8 Primary Shield Weld Quality Control (QC)

Primary shield welds include all seam welds between adjacent steel plates used to assemble the facility HEMP shields as described in this subsection. Primary shield welds also include all welds used for installing penetration protective devices under subsections WAVEGUIDE INSTALLATION, INSTALLATION OF FILTER/SURGE ARRESTER ASSEMBLIES, INSTALLATION (INCLUDING REINSTALLATION) OF SHIELDED EQUIPMENT ACCESS PANELS, INSTALLATION OF SHIELDED DOORS and INSTALLATION OF SPECIAL PROTECTIVE MEASURES. All primary shield welds shall be inspected and tested for quality in three phases:
Phase 1: In-Progress Weld Inspections and Tests.
Phase 2: Preliminary Shielding Effectiveness Testing as described in this subsection, and Phase.
3: Shielding Effectiveness Acceptance Testing as described in this subsection under Shielding Effectiveness Acceptance Testing.

3.9 Quality Control

Inspections and functional checks of filters, electrical surge arresters, and associated wiring and circuits shall be performed in accordance with the HEMP Quality Control Plan and Procedures and requirements of DIVISION 26 - ELECTRICAL. All HEMP filter/ESA assemblies shall also be PCI acceptance tested.

Quality control for primary shield welds used in HEMP filter/ESA assembly installations shall include in-progress primary shield weld inspections and testing, preliminary shielding effectiveness testing, and shielding effectiveness acceptance testing. Welds at conduit penetrations into filter/ESA assembly enclosures and through facility HEMP shield and conduit joint welds in conduit runs from the filter/ESA enclosure to the HEMP shields are primary shield welds.

RF seals between filter cases and the enclosure barrier plate that separates the "clean" compartment from the "dirty" compartment shall be visually inspected for quality. A 100-400 MHz radiated RFI Illumination Test shall be performed on the filter/ESA assembly. For assemblies mounted outside of the shield, the "dirty" cover shall be removed, for the RF seal check, and the transmitting antenna should be outside of the shield with the receiving antenna inside of the shield to detect leakage. For assemblies mounted inside of the shield, the "clean" cover shall be removed, and the transmitting antenna should be inside of the shield with the receiving antenna outside of the shield to detect leakage. Detailed procedures for this test and corrective actions if excessive leakage is detected shall be provided as an appendix to the HEMP Quality Control Plan or as a separate document.

Results of quality control inspections and tests on filter/ESA assembly installations shall be reported to the Contracting Officer in the Daily HEMP QC Reports.

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BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 908	(1989B; R 1999) Information Sheet: Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
ANSI/AGMA 2001	(2004D; R 2010) Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
ANSI/AGMA 2015-1	(2001A; R 2014) Accuracy Classification System - Tangential Measurements for Cylindrical Gears
ANSI/AGMA 6013	(2006A; R 2016) Standard for Industrial Enclosed Gear Drives
ANSI/AGMA 6113	(2016B) Standard for Industrial Enclosed Gear Drives (Metric Edition)

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B30.2	(2022) Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
ASME B30.10	(2019) Hooks
ASME HST-4	(2021) Performance Standard for Overhead Electric Wire Rope Hoists
ASME NOG-1	(2020) Rules for Construction of Overhead

	and Gantry Cranes (Top Running Bridge, Multiple Girder)

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z359	(2013) Fall Protection Code

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D14.1/D14.1M	(2019) Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

ASTM INTERNATIONAL (ASTM)

ASTM A275/A275M	(2023) Standard Practice for Magnetic Particle Examination of Steel Forgings
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A931	(2008; R 2013) Standard Test Method for Tension Testing of Wire Ropes and Strand
ASTM A1023/A1023M	(2021) Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes
ASTM E543	(2021) Standard Specification for Agencies Performing Non-Destructive Testing
ASTM E1417/E1417M	(2016) Standard Practice for Liquid Penetrant Testing
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2020) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC

NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA ICS 8	(2011) Crane and Hoist Controllers
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 7 2023; TIA 23-15) National Electrical Code

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC A348	(2020) RCSC Specification for Structural Joints Using High-strength Bolts

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)
29 CFR 1910.179	Overhead and Gantry Cranes
29 CFR 1910.306	Specific Purpose Equipment and Installations

UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 943	(2016; Reprint Sep 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1004-1	(2012; Reprint Nov 2020) UL Standard for Safety Rotating Electrical Machines - General Requirements
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices

1.2 DEFINITIONS

a. Bridge Crane: That part of an overhead crane system consisting of girder(s), end trucks, end ties, walkway, and drive mechanism which carries the trolley(s) and travels along the runway rails parallel to the runway.

b. Crane Runway: The track system along which the crane operates horizontally, including track hangar rods, track connection devices, and runway structural supports.

c. Dead Loads: The loads on a structure which remain in a fixed position relative to the structure.

d. Girder: The principal horizontal beam of the crane bridge. It is supported by the crane end trucks.

e. Lifted Load: The load consisting of the rated load and the weight of lifting devices attached to the crane such as the load block, bucket, or other supplemental devices.

f. Pendant: A control for a hoist and a crane. The pendant hangs from the hoist or the crane by a cable at a height that is easy for the operator to reach.

g. Rated Load: The maximum working load suspended under the load hook.

h. Standard Commercial Cataloged Product: A product which is currently being sold, or previously has been sold, in substantial quantities to the general public, industry or Government in the course of normal business operations. Models, samples, prototypes or experimental units do not meet this definition. The term "cataloged" as specified in this section is defined as "appearing" on the manufacturer's published product data sheets. These data sheets must have been published or copyrighted prior to the issue date of this solicitation and have a document identification number or bulletin number.

i. Top Running Crane: An electric overhead traveling crane that runs on rails on top of support girders.

j. Trolley Load: Weight of the trolley and its associated equipment carried by the trolley wheels.

k. Operating Environments:

(1) General Purpose Service: This applies to most cranes and are, in large measure, the manufacturers' standard designs. Cranes should be classified as General Purpose Service if they are operating in routine environments.

(2) Ordnance/Explosives Handling: Cranes handling palletized or unpackaged ammunition, missiles, torpedoes, and other types of ordnance. Minimum requirement of CMAA service class D.

(3) Hazardous (Explosive) Environments: Cranes operating in hazardous environments as defined by the cognizant activity safety office must be equipped with electrical safety features that meet NEC Article 500. The activity safety office will identify the specific Class, Division, and Group, as well as the envelope that

the hazard exists, to allow proper design and shall list these in this section. Choose materials for mechanical components to minimize the potential for sparking, typically bronze, stainless steel, or aluminum. Hazardous environments are split into two groups: minimum anti-spark protection and maximum anti-spark protection.

(a) Minimum Anti-Spark Protection is used when only the load block enters the explosive area.

(b) Maximum Anti-Spark Protection is used when the hazardous area envelops the entire crane.

1.3 SYSTEM DESCRIPTION

The requirements for the crane runway system and rail supporting structures are specified in Section 05 12 00 STRUCTURAL STEEL, and must conform to AISC 360.

1.3.1 Crane Design Criteria

Cranes will operate in the given spaces and match the runway dimensions and rails indicated. Hook coverage, hook vertical travel, clear hook height, lifting capacity, and load test weight must not be less than that indicated.

1.3.1.1 General

Include the following: Number of cranes two, located in building identified as Buckley Power Independence, with the capacity expressed in tons, for each overhead electric traveling (OET) crane. Also clearly locate and identify each multiple girder hoist and system components.

1.3.1.2 Classification

Provide top running overhead electric traveling (OET) multiple girder crane s conforming to CMAA 70 service class C for operation in an indoor environment, general purpose service, meeting the requirements of ASME B30.2, with an ambient temperature range of 45 to 100 degrees Fahrenheit. The crane span must be in accordance with the construction drawings with a vertical lift of 18.5 feet and as specified herein.

The crane must be pendant controlled and operate in the spaces and within the loading conditions indicated. The crane must operate on 480-volts AC, 60 Hz, three phase power source. Maximum crane wheel loads (without impact) due to dead, trolley, and lifted loads, with the trolley in any position, must not cause a more severe loading condition in the runway support structure than that produced by the design wheel loads and spacing indicated.

1.3.1.3 Rated Capacity and Speeds

Provide crane with rated capacity of 10 tons. Lower load block or assembly of hook, swivel bearing sheaves, pins, and frame suspended by the hoisting ropes are not considered part of the rated capacity.

The building has been designed for crane loads shown on sheet S-001. Should the crane design be requried to exceed these loads, the government shall be notified immediately.

Rated (maximum) speeds plus or minus 10 percent (feet/min) for the main hoist, bridge, and trolley at the rated load are specified in the table below. The minimum speed must not exceed the values listed. Values in the table are for a fully loaded crane.

Rated Speeds feet/min		
Description	Minimum	Maximum
Main Hoist	5	20
Trolley	5	125
Bridge	5	150

1.4 VERIFICATION OF DIMENSIONS

The Contractor is responsible for the coordination and proper relation of their work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

1.5 SUBMITTALS

Include in submittals the information required by the "CFCI Equipment Electrical Data" submittal in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as described in Section 01 33 00 Subpart "Contractor-Furnished Items Requiring Electrical Interface".

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overhead Electric Traveling Crane; G, DO

Complete Schematic Wiring Diagram; G, DO

SD-03 Product Data

Gear Reducers

Hoist Brakes

Travel Brakes

Load Blocks and Hooks

Wheels

Hoists; G, DO

Sheaves

End Trucks

Bridge Rails

End Stops; G, DO

Bumpers

Variable Frequency Drives; G, DO

Motors; G, DO

Runway Conductor System; G, DO

Bridge Conductor System; G, DO

Limit Switches; G, DO

Pendant Pushbutton Station; G, DO

Controls; G, DO

Control Parameter Settings; G, DO

Capacity Overload Protective Device; G, DO

Painting System

SD-05 Design Data

Load and Sizing Calculations; G, DO

SD-06 Test Reports

Hook Proof Test; G, RO

Hook Non-destructive Test (NDT); G, RO

Post-erection Inspection; G, RO

Operational Tests; G, RO

Hook Tram Measurement; G, RO

Load Tests; G, RO

SD-07 Certificates

Wire Ropes; G, RO

Crane Runway System; G, RO

Hazardous Material

Loss of Power Test

Coupling Alignment Verification Record; G, RO

Overload Test; G, RO

Brake Adjustment Record; G, RO

Compliance with Listed Standards; G, RO

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G, RO

1.5.1 Submittal Coordination and Sequencing Requirements

See references to this Specifications Section and/or specific submittal items in Section 01 33 00, as well as requirements herein and as referenced in other parts of this contract, for coordination and sequencing of submittals and the associated work to be performed.

1.6 QUALITY ASSURANCE

1.6.1 Manufacturer Qualification

Overhead Electric Traveling Crane must be designed and manufactured by a company with a minimum of 10 years of specialized experience in designing and manufacturing the type of overhead crane required to meet requirements of the Contract Documents. Crane design shall be accomplished by, or directly supervised by, a registered professional engineer (PE). PE licensing must be by a board or agency authorized to license and register professional engineers. The PE may be a Contractor's regular employee or a consultant. The PE's review and attestation of specification compliance and professional responsibility must be signified by his or her PE original seal and dated signature on the final drawings. The professional engineers must only undertake and perform work under this contract in the branch(s) of engineering in which they are licensed.

1.6.2 Pre-Delivery Inspections

Contractor is responsible for performance of quality control inspections, testing, and documentation. Submit all crane test data recorded on appropriate test record forms suitable for retention for the life of the crane.

1.6.2.1 Inspection of Steel Castings

Visually inspect load-carrying steel castings. All load bearing components, couplings, shafts, and gears, in the hoist drive train must be rolled or forged steel, except brake drums which may be ductile iron. Methods of repairing the discontinuities is subject to review by the Contracting Officer.

1.6.2.2 Inspection of Hook Assembly

Inspect hook prior to delivery. Furnish documentation of hook inspection to Contracting Officer prior to field operational testing. As part of the acceptance standard, linear indications greater than 1/16 inch are not allowed. Welding repairs of hook are not permitted. A hook showing linear indications, damage or deformation is not acceptable and must be replaced immediately.

1.6.2.2.1 Hook Non-Destructive Test (NDT)

Magnetic-particle inspect the hook over the entire area in accordance with ASTM A275/A275M. Acceptance standard is no defects. A defect is defined

as a linear indication that is greater than 1/8 inch long. For hooks of non-magnetic material, NDT will be liquid penetrant (PT) method in accordance with ASTM E1417/E1417M. For PT testing of hooks containing stainless steels, titanium, or nickel based alloys, total halogens and Sulphur used in the NDT process must be controlled as specified in T9074-AS-GIB-010/271.

Inspect each hook and shank over the entire surface area by magnetic particle inspection.

a. Procedure: Conduct magnetic particle inspection in accordance with ASTM A275/A275M with the following restrictions: Do not use DC yokes (including switchable AC/DC yokes used in the DC mode) or permanent magnet yokes. Do not use automatic powder blowers or any other form of forced air other than from a hand-held bulb for the application or removal of dry magnetic particles. Remove arc strikes. Equipment ammeters must have an accuracy of plus or minus 5 percent of full scale (equipment ammeter accuracy other than that stated is acceptable provided the MT procedure states that a magnetic field indicator is used to establish and verify adequate field strength for all aspects of the inspection.)

b. Acceptance Criteria: Defects found on the hook will result in rejection of defective items for use on furnished hoist. For this inspection, a defect is defined as a linear indication for which the largest dimension is greater than 1/16 inch.

c. Test Report: Submit a test report of the magnetic particle inspection of each hook provided the Contracting Officer for approval prior to final acceptance of hoist installation. Certify test reports by the testing organization. The performing organization must provide a written statement of certification to ASTM E543, current within one year of the date the NDT was performed. The NDT procedures including technique sheets specific to the types, shapes, and size of the parts being examined must adequately describe the orientation of the hooks within the magnetizing equipment. The performing organization must have the NDT procedures and its technique sheet used for testing of the hook reviewed and approved by an independent Level III examiner. Submit the (Level III examiner) approved procedures, technique sheet, and certification to the Contracting Officer with the test report.

1.6.2.3 Hook Proof Test

Proof test the load hook per ASME B30.10. Perform the proof test prior to Hook NDT.

1.6.3 Certificates

All certifications must be dated and bear the original signature (above the printed name) of the authorized representative of the Contractor or the manufacturer of the items or equipment being certified. Each certification will clearly identify the crane, the drives, components, and location (as applicable) to which it applies:

a. Submit a Wire Ropes Certification with the wire rope manufacturer's certification that the rope meets the published breaking strength or the actual breaking strength of a sample taken from the reel and tested. Certification is to be traceable to the hoist, crane, and reel.

b. Submit a Crane Runway System Certificate stating that the new crane will operate properly on the runway; if the crane(s) cannot operate without restriction, the Contractor must indicate crane limitations.

c. Submit a Hazardous Material Certificate that the crane does not contain hazardous material including asbestos, lead, cadmium, chromium, PCBs, or elemental mercury. Products required for the designing and manufacturing of cranes must not contain the prohibited materials.

d. Submit a Loss of Power Test Certificate stating that a test may be performed in which power is removed from the crane while the hoist, bridge, and trolley are in operation.

e. Submit a Certificate of the Coupling Alignment Verification Record.

g. Submit an Overload Test Certificate stating that the crane can be periodically load tested to 125 percent (plus 5 minus 5 percent) of rated load.

h. Submit a Certificate of the Brake Adjustment Record. Provide a brake adjustment record and installation/maintenance manuals for each brake on the crane. Each brake measurement must have a tolerance traceable to the associated brake manual or documentation provided by the brake manufacturer, location of measurements, and the actual brake setting. Changes made to settings of the brake, at any time, will void the record.

i. Submit a Certificate of Compliance with Listed Standards

1.6.4 Drawings: Overhead Electric Traveling Crane

a. Submit drawings showing the general arrangement of all components in plan, elevation, and end views. Show all major features of the crane including: hook approaches on all four sides, clearances and principal dimensions, assemblies of hoist, trolley and bridge drives, motor nameplate data, overcurrent protective device ratings, and electrical schematic drawings. Include weights and centers of gravity of major components. Provide maximum wheel loads (without impact) and spacing imparted to the crane runway system track beams. Indicate the crane speeds along the runway, the trolley speeds along the bridge girder, and the hoist lifting speeds; all speeds indicated are speeds with hoist loaded with rated crane capacity load.

b. Submit shop drawings of all fabricated components. Shop drawing quality must be equivalent to the contract drawings accompanying this solicitation. Drawings must be reviewed, signed, and sealed by a registered professional engineer.

c. Provide integral schedule of crane components on each drawing. The schedule must provide a cross reference between manufacturer data and shop drawings. Components listed on the schedule of crane components must include total quantity, description, original manufacturer, and part number. Distributing agents will not be acceptable in lieu of the original manufacturer.

d. Show in the shop drawing the installed condition clearance between the crane (bridge beam and appurtenances) and building steel structure

demonstrate no clashes are present

1.6.5 Design Data: Load and Sizing Calculations

Submit complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions. Submit Drawings and calculations reviewed, signed, and sealed by a registered professional engineer verifying the load cases, sizing of the bridge girders, end trucks, travel drives, brake selections, and overcurrent protection for motors, controllers, and branch circuits. Provide a list of all codes and standards, design assumptions, equations, specified efficiencies, limits, factors of safety, component ratings, and sources of values used. Include free body diagrams or sketches of each load case. Include seismic analysis of crane.

1.6.6 Welding Qualifications and Procedures

Welding must be in accordance with qualified procedures using AWS D14.1/D14.1M as modified. Written welding procedures must specify the Contractor's standard dimensional tolerances for deviation from camber and sweep and not exceed those specified in AWS D14.1/D14.1M and CMAA 70. Welders and welding operators must be qualified in accordance with AWS D1.1/D1.1M or AWS D14.1/D14.1M.

1.7 CRANE SAFETY

Comply with the mandatory and advisory safety requirements of ASME B30.10, ASME B30.2, CMAA 70, 29 CFR 1910.147, 29 CFR 1910.179, 29 CFR 1910.306, and all applicable provisions of 29 CFR 1910 and NFPA 70. Where personal fall arrest anchorages are provided, design anchorages in accordance with ASSP Z359.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

Provide materials and equipment which are standard products of manufacturers regularly engaged in the fabrication of complete and totally functional cranes including necessary ancillary equipment. Material will be free from defects and imperfections that might affect the serviceability and appearance of the finished product. All material must be new and unused.

2.1.2 Nameplates

Secure nameplates to each major component of equipment with the manufacturer's name, address, type or style, model or catalog number, and serial number. Provide two bridge identification plates, one for each side of the bridge. Provide noncorrosive metal identification plates with letters which are easily read from the floor, showing a separate number such as BC-1, BC-2, for each bridge crane.

2.1.3 Capacity Marking

Mark the rated capacity in ton units on each side of the crane on the bridge girders. Capacity marks must be large enough to be clearly visible

from the floor. The markings must be positioned to be visible at the operator's position after the crane has been installed.

2.1.4 Safety Warnings

Affix labels in a readable position to each lift block or control station in accordance with ASME B30.2. Submit safety warnings, diagrams and other instructions suitably framed and protected for display as indicated by the Contracting Officer as follows:

Design and locate the word "WARNING" or other legend to bring the label to the attention of the operator. Provide durable type warning labels and display the following information concerning safe-operating procedures: Cautionary language against lifting more than the rated load; operating the hoist when the hook is not centered under the hoist; operating hoist with twisted, kinked or damaged rope; operating damaged or malfunctioning hoist; operating a rope hoist with a rope that is not properly seated in its hoist drum groove; lifting people; lifting loads over people; and removing or obscuring the warning label.

2.2 STRUCTURAL REQUIREMENTS

Structural requirements must be in accordance with CMAA 70, Section 3. Structural steel materials must conform to the standards permitted in CMAA 70 and AISC 360.

2.2.1 Structural Connections

High-strength bolted structural connections must be designed and installed in accordance with RCSC A348. Bolts must be of ASTM F3125/F3125M Grade A490/A490M material. Galvanized bolts are not acceptable.

Welded connections must be performed in accordance with AWS D14.1/D14.1M. Allowable stress values must comply with CMAA 70.

2.2.2 Bridge Girder or Girders

Provide wide flange beam or standard I-Beam bridge girders. If the ends of bridge girders are notched to fit over the end trucks, the notches must be reinforced with vertical diaphragms and horizontal stiffeners.

2.2.3 Bridge Rails

Provide bridge rails, crane girders and other sections that are straight and true. Make all rail joints flush and true without misalignment of running tread and design to minimize vibration. The gap between adjacent rail ends and the vertical misalignment of running treads shall not exceed 1/32 inch. Solid stock (e.g. square bar, roundstock) is not permitted as bridge rail. Center bridge rail on top flange or position bridge rail over girder web for torsion box girders. Fasten rail to girder with welded clips. Position rail clips in pairs and at not more than 36 inches on center. Bolt bridge rail joints using standard joint bars. Stagger and position rail joints directly over girder diaphragms. Provide a positive stop at bridge rail ends to prevent creep.

2.2.4 End Ties and Bridge Girder End Connections

If equalizing end trucks are used, provide rigid end ties between girders to form a frame that is rigid about the vertical and horizontal axes. If

compensating end trucks are used, provide end ties which are rigid about the vertical axis but relatively flexible about the horizontal axis to permit partial rocking motion for wheel load compensation. Provide full depth diaphragms at girder connections and jacking points. Provide horizontal gusset plates at the elevation of top and bottom end tie flanges for connection to girder ends. Make end connections with high-strength bolts in accordance with the Structural Connections section of this specification. Use tapered alignment pins to maintain original shop alignment between bridge girders and end ties/trucks.

2.2.5 End Trucks

Provide rotating type end trucks fabricated from structural steel plate to provide a rigid box section structure. Center wheels between the webs of the box section. Configure bridge and trolley trucks with a feature that limits load movement to 1 inch in the event of wheel or shaft failure. Provide jacking pads for removal of wheel assemblies. Wheel axle bearing seats must be designed such that wheel and axle bearing assembly can be removed with not more than 3 inches of jacking.

2.2.6 End Stops and Bumpers

Fit bridge girders with structural steel end stops. Locate stops to permit maximum trolley travel. Fit bridge end trucks and trolley frames with shock-absorbing bumpers capable of decelerating and stopping the bridge and trolley within the limits stated by 29 CFR 1910 and CMAA 70. Bumpers must fully engage end stops. Mount bumpers so that there is no direct shear on mounting bolts (if any) upon impact. Bumpers must provide adequate clearance between the crane and surrounding structure when compressed to preclude damaging equipment. Ensure bridge and trolley bumper retention in accordance with ASME B30.2. When more than one crane is located and operated on the same runway, bumpers shall be provided on their adjacent ends or on one end of one crane. Fit the other end of the end-truck with a structural steel stop to engage the bumpers of the adjacent crane. Ensure bridge bumpers are properly aligned with runway end stops. Submit the EndStop calculations along with details of its connection to the runway girder..

2.2.7 Seismic Forces

Perform a seismic analysis as a part of the design of the crane in accordance with ASCE 7-16 or ASME NOG-1. The seismic analysis must be included in the CMAA 70 extraordinary load case (Case 3). For project locations beyond the scope of ASCE 7-16, a widely accepted design standard may be used for seismic analysis.

2.3 MECHANICAL REQUIREMENTS

a. Provide steel shafts, gears, keys, and couplings. Cast iron and aluminum used to support components of the hoist power transmission train must be ductile.

b. All bearings, except those subject only to small rocker motion, must be anti-friction type. All connections subject only to small rocking motion are to be fitted with bushings or thrust washers in the pivot pin bore, as applicable. Bronze bushings must have provisions for grease lubrication.

c. All mechanical components must be accurately aligned and positively

secured to maintain the alignment. Parts must not be forced into position to obtain apparent alignment.

2.3.1 Hoists

Provide hoist conforming to ASME B30.2 and CMAA 70 service class C or better, double reeved, except as modified and supplemented in this section.

2.3.2 Drives

2.3.2.1 Bridge Drives

Provide either A-1 or A-4 bridge drive arrangement as specified in CMAA 70 consisting of a single electric motor mechanically connected through gear reduction and drive shafts to the drive wheels or separate drive motors at each end of bridge.

Acceleration and deceleration must meet the requirements specified in this section. Gears must conform to applicable AGMA standards. Provide oil tight fully enclosed gear reducers with pressure or splash type lubrication. Bridge travel limit switches are optional.

2.3.2.2 Trolley Drives

Provide complete trolley drive arrangement with a minimum of two wheels driven by an integral electric motor. Drive mechanism must run in totally enclosed oil bath. Limit switches are optional for drive mechanism. Acceleration and deceleration controls must meet requirements specified in this section.

2.3.3 Load Blocks and Hooks

The load block must be constructed of steel and designed to prevent steel-to-steel contact of moving parts. The block must be fully enclosed, concealing the sheaves and wire ropes, except for wire rope slots and drain holes. The block must be clearly marked with the capacity in pounds on both sides.

Provide an unpainted single barbed forged steel hook complying with ASTM A668/A668M. Hook dimensions must be as shown on the drawings. Fit hook with a safety latch designed to preclude inadvertent displacement of slings from the hook saddle. The hook and hook nut must be removable without unreeving of the hoist. Provide hook nut with a removable type set screw or other similar fastener, installed in a plane parallel to the longitudinal axis of the hook shank. Do not weld hook nut. Hook must be free to rotate through 360 degrees when supporting the test load up to 125 percent of the rated capacity. Provide only hooks which are designed and commercially rated in accordance with CMAA and conforming to ASME B30.10 and CMAA 70.

2.3.4 Wire Ropes

a. Wire ropes must conform to ASTM A1023/A1023M and be tested as required by ASTM A931. The wire rope must be in a double reeved configuration and equalized with a sheave. Provide wire rope with a minimum design factor of 5 to 1 based on the load experienced at rated capacity and minimum breaking strength of the wire rope.

b. Provide hoisting ropes with improved plow steel, extra improved plow

steel, or extra-extra improved plow steel, regular lay, bright, and uncoated with an independent wire rope, wire strand, or otherwise, steel core. Hot-dipped galvanized wire rope is not permitted.

c. Maximum hoisting rope fleet angles must be 4 degrees for drums and 4.75 degrees for sheaves. Hoisting rope end connections, other than drum connections, must be speltered sockets with forged steel terminals or swaged fittings installed in a fashion that provides 100 percent of the breaking strength of the wire rope. Provide proof of Wire Rope breaking strength. Wedge sockets or aluminum swages are not permitted on wire rope end connections.

2.3.5 Sheaves

Provide steel sheaves. Minimum pitch diameters must be 18 times the rope diameter for running sheaves, and no less than 12 times the rope diameter for equalizer sheaves. Sheave surfaces which contact wire rope are not to be painted.

2.3.6 Hoist Drum

Provide drum made of steel. Design the drum so that not less than two dead wraps of hoisting rope remain on each anchorage when the hook is in its extreme low position. Drum grooving must be machined right and left hand beginning at the ends and grooving toward the center of the drum. Minimum drum groove depth must be 0.375 times the rope diameter. Minimum drum groove pitch must be either 1.14 times the rope diameter or the rope diameter plus 1/8 inch, whichever is smaller. Minimum drum pitch diameter must be 18 times the rope diameter. Do not paint, coat, or galvanize the surface of the drum which comes in contact with wire rope.

For wire rope drums installed directly onto the output shaft of the hoist speed reducer without an intermediate flexible coupling, the drum to shaft connection must be a barrel coupling.

2.3.7 Gearing

Provide gearing of the enclosed gear reducers type. Provide steel spur, helical, or herringbone type gears and pinions only. Gearing must conform to ANSI/AGMA 2001 and AGMA 908. Internal and external gear dimensional tolerances must conform to the applicable AGMA standard for tooth geometry and tolerances. Open-type gearing is not acceptable, except for final drives.

2.3.7.1 Gear Reducers

Gear reducers must be integral components of standard hoists or hoist/trolley units of manufacturers regularly engaged in the design and manufacture of hoists or hoist/trolley units for Class A, B, or C cranes. Gear reducers must be designed, manufactured, and rated in accordance with ANSI/AGMA 6113 (ANSI/AGMA 6013) (for trolley drives only), as applicable. Except for final reduction, the gear reduction units must be fully enclosed in oil-tight housing. Gearing must be designed to AGMA standards and operate in an oil bath. Operation must be smooth and quiet.

2.3.7.2 Open Gearing

Provide all gears and pinions with adequate strength and durability for the crane service class and manufactured to ANSI/AGMA 2015-1 Accuracy

Grade A8 or better. Open gears must be enclosed with safety guards provided with openings with covers for inspection and access for grease lubrication.

2.3.8 Wheels

Provide double flanged, straight tread trolley and bridge travel wheels of rolled-to-shape or roll-forged steel. The rim, flanges, and wheel tread must be hardened to not less than 320 Brinell Hardness Number (BHN). Wheel sizing and flange-to-rail head clearances must be in accordance with CMAA 70 recommendations.

2.3.9 Bridge and Trolley Travel Brakes

Provide bridge and trolley drives with electro-mechanical brakes or non-freecoasting mechanical drive capable of stopping the motion of the bridge or trolley within a distance in feet equal to 10 percent of the full load speed in feet per minute when traveling at full speed with a full load. Brakes must have an externally accessible means to manually release the brake.

2.3.10 Hoist Brakes

a. Equip hoist with a minimum of two holding brakes, each with a minimum torque rating of 125 percent of the rated load hoisting torque..

c. Electro-mechanical or thruster brake must have an externally accessible means of manual release.

2.4 ELECTRICAL REQUIREMENTS

The design, selection, rating, and installation of the electrical portions of the crane and its accessories must conform to the requirements of NEMA ICS 3, NEMA ICS 8, ASME HST-4, and NFPA 70, and other requirements specified herein.

The crane manufacturer must furnish and install all electrical equipment on the crane conforming to NEMA ICS 6, including motors, conforming to NEMA MG 1, electrically released brakes, switches, crane controllers, panels, operating station, wiring system, cables, and bridge-to-trolley crane electrification, and the runway electrification.

2.4.1 Motors

Motors must meet all applicable requirements of NEMA MG 1 and UL 1004-1. Provide insulated duty motors for Variable Frequency Drives (VFD). Motor insulation must be Class H, but with a Class B temperature rise. Provide motor overload protection utilizing a thermal sensitive device embedded in its windings.

2.4.2 Controls

a. Provide static reversing, variable frequency drives (VFD) for the bridge, trolley and hoist electric controls. Provide static reversing, VFD, speed regulated, closed loop, flux vector electric controls for the hoists. For feedback, provide hoist motors with encoders. The hoist controller must enable the drive motor to develop full torque continuously at zero speed. The hoist secondary brake shall be controlled separate from the primary and connected to

different output (within the drive) from the primary brake. VFD controllers must meet NEMA ICS 8, Part 8 and at a minimum, provide under-voltage protection, electronic instantaneous over current protection, DC bus over voltage protection, and be able to withstand output line to line shorts without component failure. Select bridge and trolley drives such that the continuous rating of the controller is not less than the calculated motor full load current based on CMAA 70 5.2.9.1.1.1 and NEC Table 430.250. Select hoist drives such that the continuous rating of the controller is not less than 130 percent of the calculated motor full load current based on CMAA 70 5.2.9.1.1.1 and NEC Table 430.250. All hoist drives must have a motor over-torque limit to lock out the hoist and prevent gross overload of the associated hoist. Provide dynamic braking for each electric drive that is sized per VFD manufacturer's requirements. Submit VFD Control Parameter Settings.

b. Provide speed control which is infinitely variable for each function, controlled via radio control system or pendant pushbutton station. Provide controls designed such that the maximum speed of each function will be limited to 25 percent of rated speed when a slow speed switch is actuated on the controllers. Energize a yellow/amber light/indicator while in slow speed mode.

c. The hoist, trolley and bridge brakes must set after the associated controller decelerates the drive motor to a controlled stop. The hoist, trolley, and bridge controllers must be sized to provide sufficient starting torque to initiate motion of that crane drive mechanism from standstill with 0 to 125 percent of rated load on the hook. The hoist controller must prove torque before release of the brakes and enable the drive motor to develop full torque continuously at zero speed. Motors must operate smoothly at all speeds without torque pulsations, and must only be energized within the frequency range of 50-60 Hz at rated speed.

d. The use of definite purpose contactors is prohibited. If IEC contactors are used, the application cannot exceed the contactor manufacturer's AC3 ratings for the contactor at a minimum.

e. On hoist function roll-up must be less than 1/8 inch measured at the hook block and roll-back must not occur over the entire load range.

f. Use of Uninterruptable Power Supplies (UPS) is prohibited. Feed control circuits from a single phase, air cooled, double wound transformer with a grounded metal screen between the primary and secondary windings of the transformer.

g. Provide a main line contactor. Energization of the main line contactor must be controlled by the POWER-OFF/POWER-ON switch/pushbutton on all controllers. Upon actuation of the POWER-OFF pushbutton; power to all drive motors, brakes, and controls must be removed. The mainline contactor must not be able to be energize while the POWER-OFF pushbutton is actuated. The POWER-OFF pushbutton circuitry must be independent of all controls or any other electronic devices.

2.4.3 Protection

Protection must not be less than that required by NEMA ICS 8, CMAA 70, NFPA 70,UL 1004-1, UL 1449, UL 489, UL 50, UL 943, 29 CFR 1910.147,

29 CFR 1910.179, 29 CFR 1910.306 and all applicable provisions of 29 CFR 1910. Provide enclosed type circuit breaker readily accessible to the crane operator for crane disconnect. Provide an On/Off button that removes power from the motors, brakes and control circuit on all operator control stations and or radio controllers. Provide for lockout/tagout of all hazardous energy sources.

2.4.4 Resistors

Provide resistors with natural convection cooling sized as recommended by the VFD OEM and fabricated of corrosion resistant metal; the use of "wire wound" type resistors is prohibited for segments of 8 ohms or less. Mount resistors in substantial, ventilated enclosures constructed entirely of non-combustible materials. Provide resistors with terminals fitted in the coolest position in the enclosure.

2.4.5 Transients and Harmonics Protection

a. Provide contactors and relays with appropriate Metal Oxide Varistors (MOV) or resistor-capacitor (R-C) surge absorbers installed across the respective coil.

b. Provide transient protection for electronic drive controllers that is either internal to the drive or via an MOV connected line-to-ground close to the line terminals of the drive.

c. Provide line reactors rated for continuous duty operation based upon the motor nameplate amperes. With motors of 50 horsepower or greater, harmonics protection must be provided by an isolations transformer or as recommended by the VFD OEM. For a drive motor branch circuit that exceeds 150 feet in length, a reactor must also be connected in series with the controller load (output) terminals to provide standing wave protection or as otherwise recommended by the VFD or motor OEM.

2.4.6 Limit Switches

a. Provide primary upper and lower geared limit switches. Geared limits must allow reversing direction to back out of the limit without resetting. The lower limit switch must be set such that there are a minimum of two wraps of rope on the hoist drum.

b. Provide a backup mechanical hook block activated upper limit switch wired independent of the directional controllers and the primary upper limit switch that removes power from the hoist motor, hoist brake and hoist controls conforming to NEMA ICS 5. The backup limit must require hoist resetting prior to operation of the hoist in any direction.

c. Travel limit switches must be provided for the bridge and trolley motion to slow the crane to 25 percent of its rated speed 10 feet before the bridge end stops and 2 feet from the trolley end stops. Limit switches must be mounted rigidly in a manner so as to protect the switch from misalignment or damage. The target/trip arm must be large enough to provide interception given a misalignment were to occur.

2.4.7 Operator Controls

a. Provide crane equipped with a pendant pushbutton station.

b. If VFD controls are not provided, provide directional contactors with both mechanical and electrical interlocks.

2.4.7.1 Pendant Pushbutton Station

The cranes must be controlled from a pendant pushbutton station suspended from the trolley . Provide multiconductor flexible cords for pendant pushbutton stations with No. 16 AWG minimum conductors. Provide a method of strain relief to protect the electrical conductors from damage. Locate the pendant pushbutton station 4 feet above the finished floor. Pushbutton pendant station must have its elements legibly marked and arranged vertically, in order, in accordance with CMAA 70. Provide one speed pendant pushbuttons for control of the hoist bridge and trolley. Provide pendant pushbuttons for control that spring return to the OFF position. Voltage in the pendant pushbutton station must not exceed 150 Volts AC or 300 Volts DC. Provide a maintained two-position selector switch for slow speed selection.

2.4.8 Electrification Systems

2.4.8.1 Runway Conductor System

a. Provide a rigid runway Conductor Bar System for the runway conductor system, including all necessary cables and hardware to the crane from a wall or column mounted disconnect switch. Provide electrification system with three power conductors and an equipment grounding conductor. The crane must be grounded through the runway electrification system. Provide runway conductors sized for simultaneous motions of the hoist, bridge, trolley mechanisms and any ancillary loads. If there is any way the hook block or wire rope can swing into the runway electrification, provide a guard installed to prevent contact.

b. Provide two Collector Shoes (tandem design) for each conductor; each collector shoe must be rated for not less than the overcurrent protective device for the runway conductor system, so as to provide redundancy.

2.4.8.2 Bridge Conductor System

a. Provide a totally enclosed flexible cable tray electrification system (cable chain) for the bridge conductor system. The cable chain must have three power conductors, an equipment grounding conductor, and all necessary control cables. The conductors must be selected so as to be of the longest length without splices and must be copper. A minimum of 20 percent of the control circuit conductors in the flexible cable tray system must be spares at the time of crane acceptance. The trolley is required to be grounded through this conductor system.

2.4.9 Capacity Overload Protective Device

a. Provide a capacity overload protective device for all bridge, runway, and hoist systems. Hoist overload protection must shut off lifting motion of hoist when load reaches approximately 110 percent of hoist capacity. In case of an overload condition the hoist shall stop travel in the upward direction. The load shall then be lowered to the floor and removed from the hook to reset the load cells.

2.4.10 Enclosures

a. Provide enclosures for control panels, controls, and brakes in accordance with NEMA 250 and NEMA ICS 6, Classification Type 1 indoor, general purpose . Provide enclosures with listed drains to prevent accumulation of water within the enclosure. There must not be any condensation inside the control panels. If anti-condensation heaters are provided, these heaters must remain energized when the main line contactor is deenergized.

b. Provide a non-resettable hour meter, connected across the main line contactor, readable from the exterior of the main control panel, to indicate the elapsed number of hours the crane is energized.

c. Gaskets of enclosures and fixtures, and joints and contact surfaces of hazardous/explosive enclosures must be kept free of any paint to prevent damage during removal and reinstallation of gaskets of enclosures.

2.4.11 Indicator Lights

Provide Indicator Lights mounted in an enclosure on the bottom of the bridge with lights sized and positioned to be visible from the ground. The lights must be the dual-lamp type. Provide a white light to indicate that power is available on the load side of the crane disconnect and a blue light to indicate that the main contactor is energized. Light voltage must be 115 VAC. Provide nameplates that are legible from ground level. The nameplates must read, in their respective order, "POWER AVAILABLE" and "CRANE ENERGIZED". The POWER AVAILABLE light must be supplied by a separate, fused transformer for its energization.

2.5 PAINTING SYSTEM

a. Remove all grease, oil, and surface debris by solvent wiping or detergent/water scrubbing, prior to blast cleaning. Prepare surfaces to be coated by abrasive blasting to SSPC SP 6/NACE No.3, Commercial Blast Cleaning, or in accordance with the coating manufacturer's requirements, whichever is more stringent.

b. Use a painting system appropriate for the conditions provided in the Crane Design Criteria section. Paint exposed portions of the crane using a three -coat system as follows: zinc-rich primer consisting of a minimum of 85 percent zinc by weight in the dry film, an anticorrosive epoxy intermediate coat, and an aliphatic polyurethane top coat . All paint products must be supplied by a single manufacturer and free of chromates, lead, and mercury. Apply each coat in accordance with manufacturer's instructions and requirements. Ensure each coat is smooth, even, and free of runs, sags, orange peel, and other defects. Desired color of finish coat is brilliant yellow . Submit product data for painting system.

c. Coat faying surfaces of bolted connections per RCSC A348, but do not apply finish paint.

d. Paint the load block brilliant yellow with black diagonal striping. Paint, coatings, or galvanizing on the following items or areas is not acceptable: hoist wire ropes, hooks, hook nuts, running bearing surfaces (including sheaves and wheel treads), grease fittings, or other items not normally painted.

e. Factory paint electrical and mechanical equipment in accordance with the manufacturer's best standard practice (for the specified environment), except that electrical equipment doors, which expose current-carrying electrical conductors when opened, must be orange.

2.6 IDENTIFICATION PLATES

Furnish and install identification plates. Provide non-corrosive metal identification plates with clearly legible permanent lettering giving the manufacturer's name, model number, serial number, capacity in both kilogram and pound units printed in different colors, and other essential information or identification.

2.6.1 Markings on Crane, Trolley, and Hook

To avoid operation of the crane in the wrong direction, affix the appropriate directions (NORTH, SOUTH, EAST, and WEST) with arrows on the bottom of the girder where they can be easily seen by the operator and from the loading point. Provide labels on the controls with corresponding directional (NORTH, SOUTH, EAST, and WEST) markings. Markings shall agree with the markings on controller. Do not indicate directional arrows on controller.

Mark the hook rated capacity in pounds on both sides of the hoist load block.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, and before performing any work, verify all dimensions in the field. The Contractor is responsible for the coordination and proper relation of the contracted work to the building structure and to the work of all trades. Verify all dimensions of the building that relate to fabrication of the crane and notify the Contracting Officer of any discrepancy before finalizing the crane order.

3.2 SHOP ASSEMBLY AND TESTS

Shop assemble major components as completely as possible, except for reeving of drums and sheaves. Functionally test the crane system at the construction facility prior to shipment. The Government reserves the right to inspect the crane for compliance with this specification and to witness the functionality tests. Notify the Contracting Officer 14 days prior to starting testing operations.

3.3 ERECTION AND INSTALLATION

Perform the entire crane erection in accordance with manufacturer's instructions under the full-time supervision of the manufacturer's representative.

3.3.1 Mechanical Alignment

Align motors, couplings, brakes, gear boxes and drive components in accordance with manufacturer's instructions. Complete the Coupling Alignment Verification Record.

3.3.2 Electrical Adjustments

Adjust control system in accordance with manufacturer's instructions. Store a copy of all Control Parameter Settings (PLC, VFD). Provide the final alignment data on the Complete Schematic Wiring Diagram, including but not limited to, timer settings, resistor tap settings, potentiometer settings, test-point voltages, supply voltages, motor voltages, motor currents. Provide the test conditions such as ambient temperature, motor load, date performed and person performing the alignment as part of the Operational Tests report.

3.3.3 Field Welding

Perform welding indoors, where possible. Surface of parts to be welded must be free from rust, scale, paint, grease or other foreign matter. Minimum preheat and interpass temperatures must conform to the requirements of AWS D14.1/D14.1M. Perform welding of girders and beams conforming to AWS D14.1/D14.1M.

3.3.4 Field Painting

Perform painting indoors, where possible. Field painting (including touch-up) must conform to the requirements of the coating manufacturer and as specified in PAINTING SYSTEM.

3.4 FIELD QUALITY CONTROL

3.4.1 Post-Erection Inspection

Provide a report of the inspection indicating the crane is considered ready for operational tests.

3.4.2 Operational Tests

Check the clearance envelope of the entire crane prior to picking or traversing any load to ensure there are no obstructions. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacture, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the crane is operational. The Contractor must furnish test weights, operating personnel, instruments, and other apparatus necessary to conduct field tests on each crane. Solid weights must be measured using calibrated equipment traceable to National Institute of Standards and Technology (NIST) with a minimum accuracy of plus or minus two percent.

3.4.2.1 No-Load Test

Raise and lower each hook through the full range of normal travel at rated speed for three complete cycles. Raise and lower each hook, testing other speeds of the crane. Verify proper operation of hoist limit switches. Operate the bridge and trolley in each direction the full distance between end stops. Operate through the entire speed range and verify proper brake operation. Verify correct operation of all indication and ancillary devices.

3.4.3 Test Data

Record test data on appropriate test record forms suitable for retention for the life of the crane. Record operating and startup current measurements for hoist, trolley, and bridge motors using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values; abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) must be justified or appropriate adjustments performed. In addition, note, investigate, and correct any high temperatures or abnormal operation of any equipment or machinery. Record hoist, trolley, and bridge speeds during each test cycle.

3.4.4 Hook Tram Measurement

Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 1/64 inch). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening from the base measurement is cause for rejection.

3.4.5 Load Tests

Perform the following tests for each hoist, as specified below.

Test loads used in this section are defined as the following:

Wire rope run-in load: 25 – 50 percent of rated load.

Rated load test: 100 percent (plus 0 minus 10) of rated load.

Overload test: 125 percent (plus 0 minus 5) of rated load.

3.4.5.1 Wire Rope Run-In

The primary purpose of this procedure is to exercise the newly installed wire rope.

Place the load on the hook. Start at ground level and hoist up to one foot below upper limit at slow speed. Hoist down to lower limit at slow speed. Repeat hoisting and lowering of the load for approximately 10 hoisting cycles, increasing the speed for each cycle. During this test, the capacity overload lockout should not activate.

3.4.5.2 Rated Load Test

3.4.5.2.1 Hoist

a. Static Load Test: With the trolley in the center of the bridge span, raise the test load approximately one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees to check bearing operation with no binding. Observe lowering that may occur which indicates a weakness in the structure or malfunction of hoisting components or brakes. Verify that maximum beam and girder deflections do not exceed CMAA 70 design limits.

For hoists with primary and secondary holding brakes, raise the test load and release the secondary holding brake while testing the primary holding brake. Hold for 10 minutes. Observe for lowering of the

load, which may indicate malfunction of hoisting components or brakes. Re-engage secondary holding brake and release the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage the primary holding brake. Recheck proper operation of time delay and ensure smooth positive stopping.

b. Hoist Mechanical Load Brake (if present): Raise test load approximately 5 feet. With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

c. Raise and lower test load through the full lift range and visually observe smooth control and acceleration between points. Completely stop the machinery at least once in each direction to ensure proper brake operation.

d. Hoist Loss of Power Test: Raise the test load to approximately 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

3.4.5.2.2 Trolley

Operate the trolley (if space is available) the full distance of the bridge rails in each direction with a test load on the hook. Check proper functioning through the range of speeds. Verify proper brake action.

3.4.5.2.3 Bridge

With a test load on the hook, operate the bridge for the full length of the runway (if space is available) in one direction with the trolley at the far end of the bridge, and in the opposite direction with the trolley at the opposite end of the bridge. Use extreme caution. Check proper functioning through the range of speeds. Check for any binding of the bridge end trucks and verify proper brake action. Record deficiencies. Secure from testing if deficiencies are found.

3.4.5.2.4 Trolley Loss of Power Test

With a test load of 100 percent of rated load, raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of trolley travel. While maintaining a safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the trolley stops and that the brake sets properly. Measure the distance required for the trolley to stop.

3.4.5.2.5 Bridge Loss of Power Test

With a test load of 100 percent of rated load, raise the test load approximately midway between the trolley and any permanent obstruction on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of bridge travel. While maintaining a

safe distance from obstructions, disconnect the main power source at the wall mounted safety switch (disconnect) to simulate a power failure. Verify that the bridge stops and that the brake sets properly. Measure the distance required for the bridge to stop.

3.4.5.3 Overload Test

3.4.5.3.1 Hoist

Disconnect or adjust the overload limit device to allow the hoist to lift the test load. Verify proper operation of the overload limit device after it is reconnected.

a. Static Load Test: With the trolley in the center of the bridge span, raise the test load approximately one foot. Hold the load for 10 minutes. Rotate the load and hook 360 degrees to check bearing operation with no binding. Observe lowering that may occur which indicates a weakness in the structure or malfunction of hoisting components or brakes.

For hoists with primary and secondary holding brakes, raise the test load and release the secondary holding brake while testing the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage secondary holding brake and release the primary holding brake. Hold for 10 minutes. Observe for lowering of the load, which may indicate malfunction of hoisting components or brakes. Re-engage the primary holding brake. Recheck proper operation of time delay and ensure smooth positive stopping.

b. Raise and lower test load and visually observe smooth control. Stop the load during raising and lowering to verify that the brakes holds the load.

c. Hoist Load Brake (if present): Raise test load approximately 5 feet. With the hoist controller in the neutral position, release (by hand) the holding brake. Document the method used to release the holding brake. The load brake must hold the test load. Again with the holding brake in the released position start the test load down at slow speed and return the controller to the "off" position as the test load lowers. The load brake must stop and hold the test load.

d. Hoist Loss of Power Test: Raise the test load to approximately 8 feet. While slowly lowering the test load, disconnect the crane's power source. Verify that the test load does not lower and that the brake is set.

3.4.5.3.2 Trolley

Operate the trolley the full distance of the bridge rails in each direction with a test load on the hook (one cycle) through the range of speeds. Verify proper brake action.

3.4.5.3.3 Bridge

With a test load on the hook, operate the bridge for the full length of the runway in one direction with the trolley at the extreme end of the bridge, and in the opposite direction with the trolley at the opposite extreme end of the bridge (one cycle). Check proper functioning through

the range of speeds. Check for any binding of the bridge end trucks and verify proper brake action. Record deficiencies. Secure from testing if deficiencies are found.

3.5 MANUFACTURER'S FIELD SERVICE REPRESENTATIVE

Furnish a qualified experienced manufacturer's field service representative to supervise the crane installation, assist in the performance of the on-site testing, and instruct personnel in the operational and maintenance features of the equipment.

3.6 OPERATION AND MAINTENANCE MANUALS

Provide two hard copies of operation and two hard copies of maintenance manuals for the equipment furnished along with an electronic copy (PDF) of each on a Compact Disc. Provide one complete set prior to performance testing and final copies upon acceptance. Provide operation manuals that detail the step-by-step procedures required for system startup, operation and shutdown. Include the manufacturer's name, model number, parts list, and brief description of all equipment and basic operating features. List in the maintenance manuals routine maintenance procedures, including weekly, monthly, semi-annual, and annual required maintenance items, possible breakdowns and repairs, and troubleshooting guides. Also include as-built drawings, piping and equipment layout, design calculations, Control Parameter Settings and printouts of any software, and simplified wiring and control diagrams of the system as installed. Secure approval of operation and maintenance manuals prior to the field training course.

-- End of Section --

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COALESCING OIL-WATER SEPARATORS
02/11, CHG 1: 11/13

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA 10084	(2017) Standard Methods for the Examination of Water and Wastewater

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM C990	(2009; R 2019) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM E165/E165M	(2023) Standard Practice for Liquid Penetrant Examination for General Industry

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 10/NACE No. 2	(2015) Near-White Blast Cleaning

U.S. AIR FORCE (USAF)

DAFMAN 32-1067	(2024) Water and Fuel Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of

1.2 SYSTEM DESCRIPTION

1.2.1 Applications

The separator shall remove free oil and suspended solids from oil-in-water mixtures of freshwater originating from generator maintenance operations. The influent oil-in-water mixture will flow by gravity to the unit which will not be located in an area with a corrosive atmosphere.

1.2.2 Influent Characteristics

Provide oil-water separator designed for a maximum flow of 27 gallons per minute. Operating temperatures of the influent oil-in-water mixture will range from 40 to 100 degrees F and ambient air temperatures will range from 40 to 100 degrees F. The specific gravity of the oil at operating oil-water temperatures will range from 0.82 to 0.88. The specific gravity of the freshwater at operating temperatures will be approximately 1.0.

1.2.3 Performance Requirements

The petroleum hydrocarbon concentration in the effluent from the oil-water separator shall not exceed the following limitations:

Contaminants	Maximum
Petroleum hydrocarbon, 30-day average	5 mg/L
Petroleum hydrocarbon, daily maximum	10 mg/L

To achieve this goal , it will be necessary to remove all free oil droplets equal to or greater than 20 microns.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" classification. Submittals not having a "G" classification are for Contractor Quality Control approval. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Separator; G, DO

Submit shop drawings for separator including principal dimensions, location of fittings and unit foundation. Include data to verify center of gravity with the unit empty and filled with water.

SD-05 Design Data

Separator; G, DO

Submit analysis, signed by a registered professional engineer, which indicates that at the calculated overflow rate, the

separator will be provided with the required square feet of projected plate separation area to achieve the specified performance under laminar flow (i.e. Reynolds number of less than 500) conditions. Calculations shall take into account the rate of flow, potential surge flow, influent concentrations, particle characteristics, fluid temperature, fluid specific gravities, and pH.

SD-06 Test Reports

Shop hydrostatic test; G, RO

Submit results of hydrostatic and dynamic testing.

Inspection

Field hydrostatic test

Preoperational test

In-service test

SD-07 Certificates

Separator corrosion protection; G, DO

Submit written verification on the fabricator's letterhead that surface preparation and coating application were performed in accordance with the manufacturer's printed recommendations for the coating system.

SD-08 Manufacturer's Instructions

Separator system; G, RO

SD-10 Operation and Maintenance Data

Separator system, Data Package 3; G, RO

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, such as subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. If special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.

1.4.2 Handling

Handle separator in such a manner as to ensure delivery to final location

in sound, undamaged condition. Take special care not to damage interior and exterior surfaces of separator, coalescing plates, and associated supports and pipe coatings or linings. Make satisfactory repairs to damaged materials at no cost to Government. Carry and do not drag materials.

PART 2 PRODUCTS

2.1 MATERIALS

Use 3/16 inch minimum thick carbon steel conforming to ASTM A36/A36M or material having equivalent structural properties and corrosion resistance for separator, hoppers, stationary and adjustable weirs, nozzles, flow distributor and energy dissipator device, bolts, seals, stiffeners, washers, and nuts. Weld in accordance with AWS D1.1/D1.1M to provide watertight separator that will not warp or deform under load. Use welders qualified in accordance with AWS Standard Qualification Procedure. Grind welds smooth and remove weld spatter. Fabricate free of kinks and sharp bends in a manner not to reduce the strength of steel to a value less than that intended by the design. Size and shape of bends shall be uniform. Clean and finish carbon steel surfaces as described in paragraph entitled "Separator Corrosion Protection."

Underground storage tanks will be managed in accordance with DAFMAN 32-1067 and documented in the Buckley SFB Spill Prevention Control and Countermeasure (SPCC) plan. Notify the Buckley SFB Tank Program Manager, Matthew Cohen (matthew.cohen.4@spaceforce.mil) when the tanks arrive at Buckley SFB.

2.1.1 Separator Corrosion Protection

2.1.1.1 Steel Separator

After shop conducted hydrostatic tests have been successfully completed, provide a MIL-DTL-24441 coating system to the interior and exterior surfaces of the separator. Prior to shop painting, abrasive blast clean the surfaces in accordance with SSPC SP 10/NACE No. 2 to a surface profile of 1 to 2 1/2 mils. Apply primer conforming to MIL-DTL-24441/1, Formula 150 applied to a minimum dry film thickness of 3 to 4 mils. Apply intermediate coat conforming to MIL-DTL-24441/2, Formula 151 applied to a minimum dry film thickness of 3 to 4 mils. Apply topcoat conforming to MIL-DTL-24441/3, Formula 152 applied to a minimum dry film thickness of 3 to 4 mils. Total dry film thickness shall not be less than 9 mils. Repair and replace areas of the coating system which are found to be damaged or defective upon delivery of equipment to the site or found to be defective due to work of the applicator. An interior polytetrafluoroethylene liner with a minimum thickness of 1/8 inch may be provided in lieu of paint coating the interior separator surfaces.

2.1.1.2 Other Than Steel Separator

After shop conducted hydrostatic tests and have been successfully completed, provide a coating system which will protect the separator from the oil-in-water mixture, and in situ soil conditions specified herein.

2.1.1.3 Cathodic Protection

For below ground metal separators, provide cathodic protection with test stations as specified in Section 26 42 13 GALVANIC (SACRIFICIAL) ANODE

CATHODIC PROTECTION (GACP) SYSTEM in addition to the protective coating.

2.1.2 External Surfaces

External surfaces and appurtenances shall be resistant to corrosion from the in situ soil, backfill material, and groundwater .

2.1.3 Internal Surfaces

Parallel plate material and orientation shall enhance oil coalescence and solids removal, and be corrosion and chemically resistant to the oil-in-water mixture as specified in paragraph entitled "SYSTEM DESCRIPTION."

2.1.4 Hardware

Bolts, stiffeners, washers, nuts, screws, pins, oil level sensors, and fittings as required shall be corrosion resistant. Provide materials that are inherently corrosion resistant and not merely treated with a corrosion-resistant coating, such as provided by the galvanizing process.

2.1.5 Accessibility

As a minimum provide access hatches over the following areas: parallel plates, oil storage compartments, Influent sampling area, effluent sampling area, oil skimmer, and weirs. Parts subject to wear or requiring adjustment, inspection, cleaning or repair shall be accessible and capable of convenient removal when required.

2.2 SEPARATION CHAMBER

Provide below ground separator to withstand hydraulic and soil loadings under static and dynamic conditions while empty and during operating conditions. Provide adequate support for additional loadings from separator appurtenances including weirs, hoppers, internal supports, parallel plate oil coalescers, equipment transportation, and rapid lowering and braking of load during handling operations. Bolt separator to weld-fabricated, structural steel skid base, or mount on manufacturer's standard base.

2.2.1 Lifting Mechanism

Fit separator with lifting lugs for handling and installation. Each lug shall carry the total dry weight of the separator and attendant appurtenances. Prominently display lifting instructions on anodized aluminum plate located on outside of separator.

2.2.2 Flanges

Use only flat face flanges and drill 150 pound ANSI Standard bolt circle and remove burrs. Use flanged piping connections that conform to ASME B16.5, welding neck type.

2.2.3 Weirs

Attach stationary weirs and adjustable weir supports to separator side walls to provide a watertight seal between adjoining compartments and trough to prevent hydraulic short-circuiting. Use carbon steel for weir plates and baffles. Provide sharp crested weirs of size and section

specified by manufacture. Provide slotted holes in weir plates and baffles or supports to permit horizontal and vertical adjustment of weir or baffle. Use nondeteriorating sealant or gaskets for mounting weir plates. Fill voids between separator wall and weir plate with sealant to make watertight.

2.2.4 Low Point Drains

Provide means at low points for dewatering separator.

2.2.5 Identification Plates

Provide anodized aluminum identification and instruction plates and stamp necessary data. Securely affix plates, in prominent location, to separator with nonferrous screws or bolts of not less than 1/8 inch in diameter.

2.2.6 Instruction Plates

Instruction plates shall describe special or required procedures to operate and service equipment, and shall include warnings of hazardous procedures and notice of safety and health requirements. Plates shall be durable and legible throughout equipment life.

2.2.7 Warning Sign

On entrances to the separator (and entrances to the vault) place a permanent sign which states the following: "DO NOT ENTER separator (OR VAULT) OR PERFORM HOT WORK ON OR IN separator UNTIL THE ATMOSPHERE HAS BEEN TESTED AND CERTIFIED GAS FREE AND SAFE."

2.3 OIL SEPARATION COMPARTMENT

2.3.1 General

The separator will provide a minimum detention time within the oil separation compartment of 45 minutes at design flow. Detention time will recomputed by calculating the volume of the separation zone within the separator and dividing this volume by the design flow rate. For computing detention time, total volume shall be reduced by 20 percent for the space occupied by settled solids (sediment) and accumulated oil at the surface.

Provide an oil separation compartment sensor measuring the depth of liquid in the compartment. The oil separation compartment sensor shall report back to the operator control room.

2.3.2 Parallel Plates

Provide parallel plates at an angle from 40 to 60 degrees with respect to longitudinal axis of the plate corrugations and space not less than 3/4 inch apart for removal of free oil and settleable solids. Configuration used shall not promote solids buildup on plates which would increase velocities to point of discharging an effluent of unacceptable quality. Maintain laminar flow at maximum design flow rate throughout plate packs including entrance and exit so as to prevent re-entrainment of oil(s) with water. Flow through plate packs shall be in a downflow mode parallel to plate corrugations or cross-flow perpendicular to plate corrugations, so that the oil collects and coalesces at high point of corrugations and rises to top of pack without clogging from oil or settleable solids.

2.3.3 Supports

Brace and support individual plates or plate packs to withstand loads associated with transportation and operation of units, including inplace cleaning. Equip each plate pack with lifting lugs or other attachments for handling and installation. Each lug shall carry total weight of plate pack . Provide adequate structural supports to facilitate inplace cleaning of plate pack.

2.3.4 Baffles

Provide oil retention baffle and stationary underflow baffle. Position underflow baffle to prevent resuspension of solids that have accumulated in secondary solids hopper.

2.4 WASTE OIL STORAGE COMPARTMENT

Provide a waste oil storage compartment with a capacity of not less than 1,000 gallons. Provide a waste oil compartment sensor measuring the depth of oil in the compartment. The compartment must be accessible via a manway to remove contents via a pump truck. Coordinate compartment invert elevations with the waste oil drain piping.

The oil storage compartment sensor shall report back to the operator control room. The sensor shall be set to alarm when the waste oil storage compartment is 80% full.

2.5 OUTLET COMPARTMENT

Provide outlet compartment of at least 200 gallons, a sampling port, and nozzles.

2.6 INDEPENDENT LEVEL ALARM SYSTEM

Provide a system that will monitor programmable liquid level setpoints of quantity and elevation as a percentage of tank capacity for both the oil/water separator compartment and the waste oil storage compartment. The system shall delineate between each individual setpoint. The system shall produce an audible and visible alarm in the event of monitoring an alarm condition. Mechanically-actuated float assemblies shall be field adjustable. The system shall be totally independent of the tank gauging system.

2.7 ACCESSORIES

Provide bolts, stiffeners, washers, nuts, screws, pins, gaskets, and fittings as required for adjustable weirs, and parallel plate packs .

2.8 FABRICATION

Provide shop fabricated, skid mounted oil-water separator, or other shop fabricated unit approved by the Contracting Officer, which is comprised of a separator containing an inlet compartment, parallel plate oil coalescing compartment, and outlet compartment.

2.8.1 Shop Hydrostatic Test

Prior to applying coatings, perform hydrostatic test at atmospheric

pressure by filling separator with water in the shop for a minimum of 4 hours. Testing shall be conducted after all seams have been cleaned and all welds have been inspected in accordance with ASTM E165/E165M. Acceptance criteria, for the hydrostatic test, is no leakage after 4 hours using a thorough visual inspection for the leaks.

2.8.2 Reduction of Solids

Inlet compartment shall reduce settleable solids to nonclogging level for parallel plates and provide a uniform oily wastewater hydraulic loading across inlet face of oil coalescing compartment, under laminar flow conditions. Equip compartment with an inlet nozzle with wastewater sampling port, nonclogging flow distributor and energy dissipator device, primary solids outlet nozzle, oil retention weir, and primary oil outlet nozzles. The oil-water separator shall be preceded by a solid water basin which includes a removable solids or trash basket. Equip the solid water basin with a hoist for servicing the trash basket. Size the basket to retain all solids larger than 3 inches in any dimensions. The solid waste basin shall have a minimum storage volume of 250 gallons.

2.8.3 Oil Coalescing Compartment

Equip oil coalescing compartment with easily removable and reinstallable, parallel, corrugated plates arranged to optimize separation of free oil from liquid carrier. Use parallel plates that are easily removable without dismantling packs and without confined space entry. Provide adjustable surface oil overflow weir with trough, oil outlet nozzle and stationary underflow baffle, oil retention baffle positioned to prevent discharge of free oil that has been separated from the carrier liquid in inlet and oil coalescing compartments. Provide access to each plate pack from top. Each bundle shall be equipped with handles or lifting rings. Plate designs that permit cleaning of plate packs in place are not acceptable.

2.8.4 Wastewater Sampling Port

Equip inlet and outlet compartments, adjustable overflow effluent weir, effluent trough, and wastewater outlet nozzle with wastewater sampling ports permitting easy access for obtaining isokinetic influent and effluent samples.

2.8.5 Connections

Connect the separator at the inlet and outlet pipe invert elevations indicated. Follow equipment manufacturer's recommendation for setting and adjusting top of weir elevations throughout unit.

2.8.6 Storage

Provide oil and suspended solids collection, storage, and transfer systems as an integral part of proposed oil-water separator system. As a minimum, the separator oil storage compartment shall have a capacity of not less than 1,000 gallons. Provide an access port to the separator oil storage compartment which allows removal of the waste oil using a vacuum-equipped truck.

PART 3 EXECUTION

3.1 INSPECTION

Inspect each component of separator for compliance with requirements specified in PART 2 PRODUCTS. Redesign or modification of equipment to comply with specified requirements, or necessary redesign or modification following failure to meet specified requirements, shall receive particular attention for adequacy and suitability. This element of inspection shall encompass visual examinations and dimensional measurements. Noncompliance with specified requirements, or presence of one or more defects preventing or lessening maximum efficiency of separator operation, shall constitute cause for rejection.

3.2 INSTALLATION

Lift separator as required without parallel plate packs in place onto level foundation using lifting mechanism provided. Level separator and bolt to supports to prevent hydrostatic uplift and ensure unit stability. Use a lifting bar through lugs to insert plate packs into separator and place on supports. Caulk around packs and pack supports with sealing compound conforming to ASTM C990 to prevent hydraulic short-circuiting. Avoid abrupt contact between the packs and the separator walls and pack supports to avoid damage. Separator system installation shall be conducted in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Hydrostatic Test

After separator has been leveled and secured to foundation and parallel plate packs are in place, level effluent overflow weir at elevation specified by manufacturer and hydrostatically test unit at atmospheric or operational pressure (for no leakage) for an additional 8 hours by filling with water. Perform the hydrostatic test prior to backfilling below ground or partially below ground installations.

3.3.2 Preoperational Test

The manufacturer's service representative shall inspect, operate, and test unit before in-service testing by the Contractor.

3.3.2.1 Tests

Tests shall include but not be limited to the following:

a. Soundness (without cracked or otherwise damaged parts).

b. Completeness in all details, as specified.

c. Correctness of setting, alignment, and relative arrangement of each component.

d. Verification of proper operation for all system components.

3.3.2.2 Preoperational Investigation and Test Report

Submit manufacturer's service representative's preoperational test report. Document inspections, operations, adjustments, and tests

performed and indicate whether they were acceptable or not. For unacceptable items, describe corrective action taken or recommended. Include detailed descriptions of points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. Include the manufacturer's certificate that equipment conforms to specified requirements and is ready for permanent operation and that nothing in installation will render manufacturer's warranty null and void.

3.3.3 In-Service Test

After hydrostatic test and preoperational test have been successfully completed and unit has been properly connected to influent and effluent piping, allow influent oil-in-water mixture previously described in paragraph entitled "SYSTEM DESCRIPTION" to flow into separator filled with water. Adjust and level surface oil overflow weirs to optimize oil skimming and minimize water overflow to oil recovery. Optimize operation of unit within 5 working days. Operate unit for a minimum of ten separator volume changes prior to testing for removal of contaminants and document testing results.

3.3.3.1 Analytical Methods

Test and sample preservation methods for test contaminants shall be in accordance with the latest revisions of AWWA 10084, APHA Standard Methods for the Examination of Water and Wastewater, EPA 600/4-79/020, EPA Methods for Chemical Analysis of Water and Wastes, or those substitute methods approved by the governing regulatory agencies having jurisdiction.

3.3.3.2 Test for Contaminants

Verify the separator efficiency by testing influent and effluent for contaminants described in paragraph entitled "Performance Requirements." If effluent quality is found to be unacceptable, then verify influent to effluent performance in particle size removal at the site. Tests shall be performed by an independent certified testing laboratory.

3.3.3.3 Sampling Procedures

Within an 8 hour period and at regular intervals collect a minimum of 10 influent and effluent samples from sampling ports provided as part of the separator. Purge each sampling port to remove built-up solids or other material prior to collecting sample. Collect wastewater samples isokinetically in clean glass containers with polytetrafluoroethylene lined caps. Collect duplicate wastewater samples in separate glass containers. Do not attempt to split sample. Use containers for other contaminants as recommended in references listed in paragraph entitled "Analytical Methods."

3.3.3.4 Acceptance Criteria

90 percent of the effluent samples taken shall not exceed the specified daily maximum limit for petroleum hydrocarbon contaminants. The remaining samples shall not exceed 10 mg/L for petroleum hydrocarbon contaminants. If the separator does not meet requirements of this specification, due to poor workmanship and wrong fabrication dimensions, the unit may be rejected. If the unit is not operating at design efficiency 5 days after

installation, Government may reject system. In the event Government rejects unit, Contractor shall remove separator or defective components and replace with acceptable unit or components and test as specified above.

-- End of Section --

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